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## SCIENCE AND THEOLOGY.

By JOHN BURROUGHS.

ONE of the latest phases of the religious thought of the times seems to be a desire to get rid of, or to explain away, the supernatural —at least to reclaim and domesticate it and convince mankind that it is not the irresponsible outlaw we have so long been led to suppose —a desire nearly as marked in the theology as in the science of the day. Thus, the Bishop of Exeter (Dr. Temple), in his Bampton Lectures of 1884, on the "Relations between Religion and Science," upholds the belief in miracles, without calling to his aid the belief in the supernatural as the word is commonly used. A miracle, he urges, *may* be only some phase of the natural not yet understood; the turning of water into wine by word of command, or the miracle of the loaves and the fishes, may have been accomplished by the exercise of some power over Nature which is perfectly scientific, but of which man as yet has imperfect control.

And the Duke of Argyll, in his "Reign of Law," cautions us against assigning an event or a phenomenon to the agency of the supernatural until we are quite sure we understand the limits of the natural—the natural may reach far enough to include all that we have commonly called the supernatural. The latest considerable attempt in this direction is furnished by the work of Professor Henry Drummond on "Natural Law in the Spiritual World," a work which undertakes to demonstrate the naturalness of the supernatural, or the oneness of religion and biology.

Butler, in his "Analogy," says that there is no "absurdity in supposing that there may be beings in the universe whose capacity and knowledge and views may be so extensive as that the whole Christian dispensation may to them appear natural; that is, analogous or con-

formable to God's dealings with other parts of his creation; as natural as the visible known course of things appears to us."

Such a being seems actually to have appeared in the person of this Scotch professor. The "whole Christian dispensation" is to him little more than a question of experimental science; the conversion of Paul is as natural and explicable a process to him as the hatching of an egg, or the sprouting of a kernel of corn. "Religion," he says, "is no disheveled mass of aspiration, prayer, and faith. There is no more mystery in religion as to its process than in biology." The question of a future life is only a biological problem to him. He gives physiological tests by which a man may surely know whether or not he is a true Christian. The characteristics of life in the organic world, he argues, are four, namely, assimilation, waste, reproduction, and spontaneous action; the characteristics in the Christian world are the same, *must* be the same, else the law of continuity, upon which he has built, fails. But he wisely refrains from applying these tests in detail to the spiritual life of the Christian. He says: "The experiment would be a delicate one. It might not be open to every one to attempt it. This is a scientific question; and the experiment would have to be conducted under proper conditions and by competent persons."

There is little mystery in the universe to a mind like Drummond's; or, if there is any mystery, he knows exactly what and where it is; he has cornered and labeled it, so that it shall give him no further trouble.

We hardly need the confession which he makes in his preface, that his science and his religion have got so thoroughly mixed that either can be expressed in the terms of the other. For a time, he says (while he was teaching the two, one on week-days, the other on Sundays), he succeeded in keeping them shut off from one another in two separate "compartments" of his mind. "But gradually the wall of partition showed symptoms of giving way. The two fountains of knowledge also slowly began to overflow, and finally their waters met and mingled. The great change was in the compartment which held the religion. It was not that the well there was dried; still less that the fermenting waters were washed away by the flood of science. The actual contents remained the same. But the crystals of former doctrines were dissolved; and, as they precipitated themselves over more indefinite forms, I observed that the Crystalline System was changed. New channels for outward expression opened, and some of the old closed up; and I found the truth running out to my audience on Sundays by the week-day outlets."

It is but fair to say that this extract does not show our professor's style at its best, but rather at its worst. At its worst it is grossly materialistic, and goes in the leading-strings of a cheap and overwrought analogy. At its best it is often singularly clear and forcible, even flexible and buoyant, but it always wants delicacy and spirituality, and appeals to the scientific rather than to the religious sense. But a

more confused mixture of science and theology probably the whole range of printed books does not afford. The positions and conclusions of the latter are constantly uttered as if they were the demonstrations of the former. And this is the obnoxious feature of the book. With Professor Drummond's theology, as such, I have nothing to do, having long ago made my peace with Calvinism. It is only because he utters his theology in the name of science, or as the result of a scientific demonstration, that I am occupied with him here.

When it is declared by a college Professor of Natural Science, as it virtually is in this book, that in the laws and processes of the physical universe that which is science at one end is Scotch Presbyterianism at the other, the proposition arrests attention by its novelty at least.

"The spiritual world as it stands," he declares, "is full of perplexity. One can escape doubt only by escaping thought. . . . The old ground of faith authority is given up; the new [ground] science has not taken its place." It is his purpose to give to faith this new ground of science. Up to this time, he says, the spiritual world has been looked upon as outside of natural law. Evolution and revelation have been at swords' points; he has not merely made peace between them, but he clearly believes himself to have enlisted the forces of the former under the banner of the latter. Science, he says, can hear nothing of a "Great Exception." The present decadence of religion is owing to the fact that it has been too long treated as the great exception—cut off by an insurmountable barrier from the natural order of things. It is now found by this Christian philosopher to be as completely under the dominion of natural law as any branch of physical science. What Jussieu and De Candolle did for botany in substituting the natural system for the artificial, what Lyell did for geology in getting rid of "catastrophism," what Newton did for astronomy by his law of gravitation, our Glasgow professor flatters himself (rather covertly, to be sure) he has done, or showed the way to do, for theology. He has introduced law and order where before were chaos and "perplexity."

All this sounds as promising to the man of science as it must sound bewildering and discouraging to the theologian—because, has not theology always maintained that revealed religion was superior to reason, and that the natural man, with his profane sciences, was at enmity with God?

Sir Thomas Browne speaks as a theologian when he says that reason is a rebel unto faith, and that "many things are true in divinity which are neither inducible by reason nor confirmable by sense"; but he spoke as a man of science when he said: "I can cure vices by physic when they remain incurable by divinity; and they shall obey my pills when they contemn their precepts." Indeed, science and divinity occupy essentially different points of view, in many respects antagonistic points of view.

Science, in the broadest sense, is simply that which may be verified; but how much of that which theology accepts and goes upon is verifiable by human reason or experience? The kind of evidence which theology accepts, or has accepted in the past, is too much like that which led the old astrologer Nostradamus to predict the end of the world in 1886, because in this year Good-Friday falls upon St. George's day, and Easter upon St. Mark's day, the very latest date upon which Easter can happen.

Theology, for the most part, adopts the personal point of view—the point of view of our personal wants, fears, hopes, weaknesses, and shapes the universe with man as the center. It has no trouble to believe in miracles, because miracles show the triumph of the personal element over impersonal law. Its strongest hold upon the mind of the race was in the pre-scientific age. It is the daughter of mythology, and has made the relation of the unseen powers to man quite as intimate and personal. It looks upon this little corner of the universe as the special theatre of the celestial powers—powers to whom it has given the form and attributes of men, and to whom it ascribes curious plans and devices. Its point of view is more helpful and sustaining to the mass of mankind than that of science ever can be, because the mass of mankind are children, and are ruled by their affections and their emotions. Science chills and repels them, because it substitutes a world of force and law for a world of humanistic divinities.

Of all the great historical religions of the world, theology sees but one to be true and of divine origin; all the rest were of human invention, and for the most part mere masses of falsehood and superstition. Science recognizes the religious instinct in man as a permanent part of his nature, and looks upon the great systems of religion—Christianity, Judaism, Buddhism, Mohammedanism, the polytheism of Greece, Rome, and Egypt, etc.—as its legitimate outgrowth and flowering, just as much as the different floras and faunas of the earth are the expression of one principle of organic life. All these religions may be treated as false, or all of them treated as true; what we can not say, speaking for science, is, that one is true and all the others are false. To it they are all false with reference to their machinery, but all true with reference to the need to which they administer. They are like the constellations of the astronomical maps, wherein the only things that are true and real are the stars; all the rest—Ursa Major, Cassiopeia, Orion, etc.—are the invention of the astronomers. The eternal truths of man's religious nature have lent themselves to many figures of polytheism as well as of Christianity; these figures pass away or become discredited, but the truths themselves—the recognition of a Power greater and wiser than ourselves, to the law of which it is necessary that our conduct in some measure conform—never pass away. Was not Egypt saved by her religion, and Greece by hers, as much as England is by hers?

Indeed, the question which it is not safe to ask of any religion is just the one we are prone to ask first, namely, Is it true? A much safer question is, Is it saving? That is, does it hold men up to a higher standard of life and duty than they were otherwise capable of? Does it cheer and sustain them in their journey through this world? Could the religion of Greece have faced the question, Is it true? And yet the German historian of Greece, Dr. Curtius, says that the religion of Apollo "was nowhere introduced without taking hold of and transforming the whole life of the people. It liberated men from dark and groveling worship of Nature; it converted the worship of a god into the duty of moral elevation; it founded expiations for those oppressed with guilt, and for those astray, without guidance, sacred oracles." Can historical Christianity any better face the question, Is it true? Did all these events fall out as set down in the New Testament? Are they set in their true light? And yet who besides Professor Clifford dare say that Christianity has not been a tremendous power in elevating and civilizing the European nations?

Science affirms that every child born of woman since the world began belonged to the human species, and had an earthly father; theology affirms that this is true of every child but one: one child, born in Judea over eighteen hundred years ago, was an exception, was indeed very God himself. Theology makes a similar claim with regard to the Bible. It affirms that every book in the world was written by a human being, and is therefore more or less fallible and imperfect, with the exception of one—that one is the Bible. This is the great exception: the Bible is not the work of man, but is the word of God himself uttered through man, and is therefore infallible. Science simply sees in the Bible one of the sacred books of the nations—undoubtedly the greatest of them all—but still a book or a collection of books embodying the history, the ideas, the religious wants and yearnings of a very peculiar people—a people without a vestige of science, but with the tie of race and the aspiration after God stronger than in any other people—a people still wandering in the wilderness, and rejected by the nations to whom they gave Christianity. Science knows God, too, as law, or as the force and vitality which pervade and uphold all things; it knows Christ as a great teacher and prophet, and as the savior of men. How? By virtue of the contract made in the Council of the Trinity as set forth in the creed of Calvinism? No; but by his unique and tremendous announcement of the law of love, and the daily illustration of it in his life. Salvation by Christ is salvation by self-renunciation, and by gentleness, mercy, charity, purity, and by all the divine qualities he illustrated. He saves us when we are like him, as tender, as charitable, as unworldly, as devoted to principle, as self-sacrificing. His life and death do inspire in mankind these things; fill them with this noble ideal. He was a soul impressed, as perhaps no other soul ever had been, with the oneness of man with God, and

that the kingdom of heaven is not a *place*, but a state of mind. Hence, coming to Christ is coming to our truer, better selves, and conforming our lives to the highest ideal. Was not Paul a savior of mankind also? Without Paul it is probable that Christianity would have cut but an insignificant figure in this world. He was its thunderbolt; his words still tingle in our ears.

I by no means say that this is the only view that can be taken of Christ as the Saviour of mankind; I say it is the only view science or reason can take—the only view which is in harmony with the rest of our knowledge of the world.

What can science, or, if you please, the human reason, in its quest of exact knowledge, make of the cardinal dogmas of the Christian Church—the plan of salvation, justification, the Trinity, or "saving grace," etc.? Simply nothing. These things were to the Jews a stumbling-block and to the Greeks foolishness, and to the man of science they are like an utterance in an unknown tongue. He has no means of verifying them; they lie in a region entirely beyond his ken.

Witness the efforts of the Andover professors, in their latest manifesto, "Progressive Orthodoxy," to give a basis of reason to the dogma of vicarious atonement. The result is mere verbal jugglery. To say that Christ, laying down his life, makes you or me, or any man, *capable* of repenting in a way or in a degree we were not capable of before, or that a man's capacity in any direction can be increased without effort on his part, and by an event of which he may never have heard, are assertions not credible, because they break completely with the whole system of natural knowledge.

In short, the truth of this whole controversy between science and theology seems to me to be this: If we take science as our sole guide, if we accept and hold fast that alone which is verifiable, the old theology, with all its miraculous machinery, must go. But if there is a higher principle by which we are to be guided in religious matters, if there is an eye of faith which is superior to the eye of reason—a proposition which I for one neither affirm nor deny—then the whole aspect of the question is changed, and it is science and not theology that is blocking the way.

But the attitude of Professor Drummond is, that there is nothing true in divinity that is not true in science, or at least in harmony with science, and the main purpose of his book is to demonstrate this fact.

The proof here offered is nothing more than the old argument from analogy, the analogy being drawn from the principles of biology instead of from the general course of nature, as with Butler. It is the assumption that these biological processes or laws are identical in the spiritual and physical spheres that furnishes the starting-point of the book. "The position we have been led to take up is not that the spiritual laws are analogous to the natural laws, but that they *are the same laws*. It is not a question of analogy, but of *identity*." Still, the

identity is not proved; the analogy alone is apparent. In the physical sphere science often recognizes the same laws appearing under widely different conditions. For instance, the process by which animal life is kept up is no doubt a real combustion, identical in kind with that which takes place in the consumption of fuel by fire. Lavoisier and Laplace long ago taught us that there are not two chemistries —one for dead bodies and another for living—on the contrary, one system of laws, chemical, mechanical, physical, everywhere prevail. Again, there are few exact terms that we apply to objective nature that we do not apply upon the principle of analogy to subjective nature, as high and low, interior and exterior, flexible and inflexible, hard and soft, attraction and repulsion, etc. Indeed, our whole language, in its higher ranges, is a perpetual application of the principle of analogy. But to aver that physical laws are operative in the spiritual world, even in the spiritual world of Calvinistic theology, is quite another matter, and is to take a leap where science can not follow. Hard and inflexible as the Calvinistic heaven is, it is doubtful if the law of gravitation reaches so far, though our professor does not flinch at all at this assumption (see page 42).

"Nature," he again says, "is not a mere image or emblem of the spiritual. It is a working model of the spiritual. In the spiritual world the same wheels revolve, but without the iron" (page 27). It is something to be assured that the iron is left out; the wheels are enough. Though why not the iron also, since we are still within reach of the same physical laws?

There is nothing more taking than the argument from analogy, but probably no species of reasoning opens so wide a door for the admission of error. It is often a powerful instrument in leading and persuading the mind, because it awakens the fancy or stirs the imagination; but its real scientific value, or its value as an instrument for the discovery of truth, is very little, if it has any at all. The fact of the metamorphosis of the caterpillar after an apparent death into a winged insect may lend plausibility to the doctrine of the soul's immortality, but can it be said to furnish one iota of proof? Indeed, to a mind bent upon anything like scientific certitude in such matters, Butler's whole argument for a future life can hardly be of a feather's weight, because he seeks to prove by reason or comparison that which experience alone can settle.

Paul reasoned from analogy when he sought to prove the doctrine of the resurrection of the body. He appealed to a perfectly natural and familiar phenomenon, namely, the decay and transformation of a kernel of wheat in the ground before it gives birth to the stalk and the new grain. But see how the doctrine which he maintained so eloquently has faded, or is fading, from the mind of even orthodox Christendom! Analogy is valuable as rhetoric, but in the serious pursuit of truth it can be of little service to us. When employed for its

argumentative force, it proceeds upon the theory that if two things be compared, a matter in question with a matter about which there can be no question, and the former be found to agree in its *rationale* with the latter, the presumption is that it is true as the latter is true. But this mode of reasoning is of no value in religious matters, because here we shape the unknown from our knowledge of the known, and the agreement between the two is already assured. The world of myth and fable bears a resemblance more or less striking to the real world, but does that afford any ground for our accepting the myths and fables as actual facts and occurrences?

Suppose the doctrine of Christian conversion, as expounded by Paul, is found to agree with certain well-known and universal facts of human life, does that prove the doctrine to be true? Or does it prove that Paul predicated his doctrine upon the knowledge of these facts? Milton's rebellious angels in their warfare against the hosts of heaven may not violate one rule of good English military tactics, but that fact would hardly be counted sufficient evidence for our accepting the rebellion as an actual historical event. Indeed, when our theological friends ask us to accept their dogmas on the ground that they are no more unreasonble or inexplicable than many things which we do believe, and which all the world believes, they usually make the mistake of expecting us to award the same weight to the argument from analogy that we do to proof from experience.

That a thing is mysterious or inexplicable affords no grounds for our refusing to credit it. We can not explain the simplest facts of our lives; we are embosomed in mystery. We do not know how our food nourishes us, or how our sleep refreshes us, yet we know that they *do* nourish and refresh us, and that is enough. What a mystery that an ugly worm should become a gorgeous butterfly, or that from a little insensate egg should come a bird with all its powers of flight and song! How wonderful and inexplicable are the commonest facts and occurrences about us! Yet we know that things do turn out thus and thus and not otherwise, and we know it not from reason but by experience. We know that a man may survive the amputation of his arms and legs, but do we know that he can survive the amputation of his head? A tree or a cabbage survives the amputation of its head; the stump will sprout again, why not a man? It is not a matter of reason, I say again, but of experience. When the doctrine of the Trinity can be confirmed by the same test, then it will be just as easy to believe it true as it is that water flows or is solid according to the temperature. The difficulty with the theologians is that, while they so often appeal to our experience in establishing their premises, they at once go beyond our experience in drawing their conclusions.

The analogy upon which Professor Drummond builds so confidently will be found comforting and reassuring to those who are already of his creed, but to the disinterested inquirer, determined to

hold fast alone to that which is verifiable, it is little more than a clever rhetorical flourish.

His argument in a nut-shell is this: There are three kingdoms—the inorganic, the organic, and the spiritual—each atop of the other, and carrying the same law into higher regions. There may be other kingdoms, he says, higher in the scale than the spiritual, or the kingdom of God, of which we as yet know nothing. But of these three we do know, and with these we have to deal. The law of evolution works in each one of these kingdoms up to a certain point, when there is a break and miracle, or an outside power steps in. There is no passage from the inorganic to the organic without a miracle, and no passage from the natural to the spiritual without a miracle. Evolution worked in the nebulous matter till the worlds were formed and ready for life: to introduce that life, God did directly step in by a creative act. This done, evolution went to work again and carried forward the process until the series of sentient beings was crowned by man. Then evolution came to the end of its tether again; to reach the spiritual kingdom the intervention of a miraculous power was again required. A man can no more become a Christian by his own will or act than the inorganic can become the organic. *He can not*—the thing is simply impossible; and our author brings Scriptural texts to support his position. This leads him into good old-fashioned Calvinism, and good old-fashioned Clavinism he advocates and seeks to clinch with his scientific hammer. Indeed, his aim is to lend the great authority of science to this all but outgrown creed, and he evidently flatters himself that he has established the truth of it beyond all question. The reader soon perceives that the spiritual world of which he is all the while talking is not the spiritual world of the rest of mankind—the world of spirit as opposed to that of matter, the world of mind and consciousness of which all men are more or less partakers by virtue of their humanity—but the spiritual world as interpreted by a certain Christian sect, a very limited and a very recent affair, of which the mass of mankind have never even heard, and in which the sages and prophets of antiquity have no part nor lot. The curious and astonishing thing about the argument is, not the bringing forward and the insisting upon this kind of a spiritual world, for theology has long ago made us familiar with this claim, but the bringing of it forward in the name of science and substituting it for the spiritual world which science really recognizes. In following his argument one constantly feels the ground disappearing beneath him, or before him. His spiritual kingdom does not belong to the same order of fact as the other two: it is not a link, or a step in a natural series, but a domain by itself entirely apart from human reason or experience. In clapping it on top of the physical universe in the way it has been done here, and claiming that its position there is logical or scientific, is to do violence to common sense. Its position there is forced and arbitrary.

In the order of Nature what goes atop of the animal world is the world of consciousness, the world of mind and spirit which attains to its full flowering in man. This is no limited or accidental world, thrust upon the few, and denied to the many, but a world which belongs to the natural order of the universe. The passage to it from the animal is so gradual that science can not say where the one ends and the other begins. In the same manner the animal fades into the vegetable, and the vegetable into the mineral. There are no breaks, there are no gulfs fixed. "There exists no insurmountable chasm between organic and inorganic nature," says Hankel, speaking for the most thorough science of his times. Huxley and Tyndall and the leading French scientists have reached the same conclusion. The organic and the inorganic are composed of the same elements; their differences arise solely from the different chemical combination of these elements, a combination so peculiar and complex that Science has not yet been able to reproduce it in her laboratory. But the fact that spontaneous generation has not yet taken place under the highly artificial conditions imposed by experimental chemistry proves what? Proves only that it has not yet taken place, that science with its limited means and brief space of time has not yet accomplished that which must have occurred under vastly different conditions in the abysm of geological time, and in the depths of the primordial seas. Science starts with matter and with force; back of these it does not go; more than these it does not require. To account for them, or to seek to account for them, is unscientific, for the simple reason that no such accounting can be verified. Out of the potencies of matter itself science traces the evolution of the whole order of visible things. Theology may step in and assume to know all that Science leaves unsaid, but, in doing so, let it not assume to speak with the consent and the authority of its great rival.

In the light of the most advanced biological science, organic and inorganic appear but relative terms, like heat and cold. There are all degrees of heat, and there are probably all degrees of life. There are probably degrees of life too low in the scale for our discernment, just as there is heat where our senses report only cold. If there are degrees of consciousness, why may there not be degrees of life? The child grows gradually into consciousness, just as the race has grown gradually into consciousness. Dare we affirm that in either case the leap from the unconscious to the conscious was or is suddenly made? No more dare we affirm that the leap from the inorganic to the organic was suddenly made. Is the crystal absolutely dead? See it shape itself according to a special plan, see how sensitive it is to the surrounding medium; see it grow when the proper food is given it, so to speak. Pasteur has noted that it cicatrizes or repairs itself when wounded. When placed in the fluid of crystallization, as in the animal, the injured part sears over and gradually regains its original shape.

The most advanced science of our time does not regard life as a special and separate principle, a real entity which has been added to matter, but as a mode in which certain physical forces manifest themselves, just as heat is not a thing of itself, but a mode of motion.

"Mechanical, chemical, and physical forces are the only efficient agents in the living organism," at least the only ones which science can recognize, and these forces are the same in both the organic and the inorganic worlds.

Behold a fire, a conflagration; see it leap and climb, witness its fierce activity, its all-devouring energies! How like a thing of life it is! Is there a unique and original principle at work here, the principle or spirit of fire, a thing apart from the intense chemical activity which it occasions? The ancient observers believed so, and it is a pretty fancy, but science recognizes in it only another of the protean forms in which force clothes itself. We can evoke fire without the aid of fire, but the fire called life man has not yet been able so to evoke—probably never will be able. The nearest he has as yet come to it is in producing many of the organic compounds synthetically from inorganic compounds—a triumph a few years ago thought to be impossible.

The barrier, then, between the organic and the inorganic, upon which the scheme of theology of Professor Drummond turns, is by no means a fixed conclusion of science. Science believes that the potencies or properties of life are on the inorganic side, and that the passage has actually taken place in the past or may still take place in the present.

In working out his general thesis, our author takes courage from the example of Walter Bagehot, whose physical politic, he says, is but the extension of natural law to the political world; and from the example of Herbert Spencer, whose biological sociology is but the application of natural law to the social world. But the political world of Walter Bagehot and the social world of Herbert Spencer are worlds which science recognizes; they fall within its pale; their existence is never disputed. But the spiritual world of Professor Drummond is a world of which science can know nothing. It is to science just as fanciful or unreal as the spiritual world of Grecian or Scandinavian mythology, or as the fairy world of childhood.

It is true the world of art, the world of genius, the world of literature, is a very select and limited affair too; but does anybody ever call the reality of it in question? Do we want proof that Shakespeare and Milton are poets? But science does want proof, if the matter comes to that, that the typical Puritan has the favor of any spiritual powers not known to the rest of mankind—not known and equally accessible to Zeno, or Plutarch, or Virgil, or Marcus Aurelius.

It is just these exceptions, these departures from the established course of Nature, that the natural philosopher is skeptical about. If an obscure event, which happened in Judea over eighteen hundred years

ago, added a new kingdom to Nature, or inaugurated a new or higher order of spiritual truths impossible before that time, impossible to Plato or Plutarch, he wants the fact put in harmony with the rest of our knowledge of the universe. It is commonly believed that the course of Nature is independent of historical events, and that the ways of God to man from the beginning have been just what they are to-day.

What perpetually irritates the disinterested reader of Drummond's book is the assumption everywhere met with that the author is speaking with the authority of science, when he is only echoing the conclusions of theology. Hear him on the differences between the Christian and the non-Christian:

"The distinction between them is the same as that between the organic and the inorganic, the living and the dead. What is the difference between a crystal and an organism, a stone and a plant? They have much in common. Both are made of the same atoms. Both display the same properties of matter. Both are subject to the same physical laws. Both may be very beautiful. But, besides possessing all that the crystal has, the plant possesses something more—a mysterious something called life. This life is not something which existed in the crystal only in a less developed form. There is nothing at all like it in the crystal. . . . When from vegetable life we rise to animal life, here again we find something original and unique—unique at least as compared with the animal. From animal life we ascend again to spiritual life. And here also is something new, something still more unique. He who lives the spiritual life has a distinct kind of life added to all the other phases of life which he manifests—a kind of life infinitely more distinct than is the active life of a plant from the inertia of a stone. . . . The natural man belongs essentially to this present order of things. He is endowed simply with a higher quality of the natural animal life. But it is life of so poor a quality that it is not life at all. 'He that hath not the Son *hath not life;* but he that hath the Son hath life'—a new and distinct and supernatural endowment. He is not of this world, he is of the timeless state of eternity. *It doth not yet appear what he shall be.*"

In the chapter on classification this distinction is further elaborated, and a picture drawn of the merely moral or upright man, that leaves him very low down indeed in the scale of life, when contrasted with the Scotch Presbyterian. He is still a stone compared with the plant: "Here, for example, are two characters, pure and elevated, adorned with conspicuous virtues, stirred by lofty impulses, and commanding a spontaneous admiration from all who look upon them—may not this similarity of outward form be accompanied by a total dissimilarity of inward nature?" And he adds that the difference is really as profound and basal as that between the organic and the inorganic.

As rhetoric, or as theology, one need care little for all this; but

when it is uttered as science, as it is here, it is quite another matter. When it is declared that a man, say like Emerson, when compared with the general of the Salvation Army, is a crystal compared to a flower, and the declaration is made in the name and with the authority of science, it is time to protest. In fact, to aver that the finest specimens of the race who lived before the advent of Christianity, or who have lived since, and honestly withheld their assent from the Calvinistic interpretation of it, came short of the higher life and the true destiny of man, as much as the stone comes short of the plant, may do as the personal opinion of a Scotch professor, but to announce such an opinion as the result of a scientific demonstration is an insult to science and an outrage upon human nature.

It is told of Dr. Johnson that he once silenced an old Billingsgate fish-wife by calling her a parallelogram. Professor Drummond calls the merely moral man a hexagon (see chapter on classification), and there is just as much science in the one case as in the other. It is a mere calling of names, and the retort in both cases is liable to be, "You're another!" That there is a fundamental difference between the crystal and the cell we all know, but to call Plato or Marcus Aurelius a crystal, and Luther or Calvin living organism, is purely gratuitous. To science Paul is no more alive than Plato. Both were master-spirits, both made a deep and lasting impression upon the world, both are still living forces in the world of mind to-day. Theology may see a fundamental difference between the two, but science does not. Theology may attach its own meanings to the terms life and death, but science can attach but one meaning to them, the meaning they have in the universal speech of mankind. Theology may say that "he that hath the Son hath life, and he that hath not the Son hath not life"; but is the statement any more scientific than it would be to say, "He that hath Confucius hath life, and he that hath not Confucius hath not life"? If Christ was the life in a biological and verifiable sense, then the proposition would carry its own proof. But the kind of life here referred to is a kind entirely unknown to science. The language, like the language of so much else in the New Testament, is the language of mysticism, and is not capable of verification by any process known to science. The facts that confirm it, if facts there are, lie entirely outside of the domain of scientific inquiry, direct or indirect.

As a matter of fact, and within the range of scientific demonstration, the difference between the Christian and the non-Christian, between the moral and the orthodox citizen, in our day, is as little as the difference between Whig and Tory, or Republican and Democrat—a difference of belief and of outward observance, and in no sense a fundamental difference of life and character. Is it probable that a scientific commission could establish any essential differences, say between Professor Tyndall and Professor Drummond, any differences which the latter owed to his orthodoxy that enhanced his worth as a man, as

a citizen, as a father, as a husband, or as a man of trust and responsibility, over and above the former? It would probably be found that both possessed "that inbred loyalty unto virtue" of Sir Thomas Browne which certainly is the main matter in this world, and more's the pity if it is not the main matter in the next.

Our professor's argument from analogy breaks down on nearly every page by his confounding the particular with the universal, and substituting the exceptional, the hypothetical, for the natural and provable. The error is the same as if Bishop Butler had sought to prove from the *general* course of Nature, such as the changing of worms into flies, the hatching of eggs into birds, the passage of infancy into manhood, etc., that some *particular* men were endowed with immortal souls and lived after the dissolution of the body. But the bishop made the two sides of his equation equal; he started with the universal and he ended with the universal, and claimed immortality for *all* men. Drummond, on the other hand, seeks to prove a particular and exceptional fact by its analogy to a general law of Nature. In his chapter on "Conformity to Type," the leading idea is that every kind of organism conforms to the type of that which begat it: the oak to the oak, the bird to the bird, etc. An incontrovertible statement, certainly. Now, what is the analogy? This, namely, that all Christians conform to the Christ-type, and are not begotten by themselves, but by Christ. Where is the *force* of the analogy? One fails to see it, because the argument proceeds from the universal to the particular again; a principle which is true of all birds, and all oaks, is true of only some men. All men are not Christians. Moreover, Professor Drummond urges that they can not all be Christians, and that the scheme of Christianity does not require or intend that they shall all be Christians.

To give the analogy force requires that the law be as general in the one case as in the other. Every bird is a bird unconditionally; it is born a bird and dies a bird, and can be nothing else but a bird; and to show the same universal law of conformity to type, working in both cases, every man must be a Christian on the same terms: it must be shown to be the law of his being from which there is no escape. If one man fails to become a Christian, the law is broken as truly as if a bird's egg were to hatch out a mouse, or an acorn to produce a cabbage. But, in the scientific Calvinism of Professor Drummond, every bird is not a bird; only one here and there has the bird-form thrust upon it. The number of Christians is of necessity very limited. Salvation, and hence immortality, are for the few, not for the many. Our Christian philosopher is actually driven by the necessities of his argument into maintaining the truth of a special and limited immortality. Immortality is not for the whole human race, any more than the principle of life is for the whole inorganic kingdom.

"Some mineral, but not all, become vegetable; some vegetable, but not all, become animal; some animal, but not all, become human;

some human, but not all, become divine." But the principle is the same, as if all mineral did become vegetable, etc. It *may* become vegetable, probably in its turn will become vegetable; there is no partiality or preference on the part of Nature. The same in the higher spheres. All men are approximately divine, such men as Plato and Paul vastly more so, of course, than the great mass of men; but the difference is one of degree, not of kind, like the difference between the half-fliers and the perfect fliers among the birds. Yet Professor Drummond dare affirm that certain members of a species are endowed with a *kind* of life which is denied to certain other members of the same species, and he makes this declaration, not in the name of theology, but in the name of science!

Far be it from me to seek to belittle or discredit the true Christian life of any man or woman—the life that conforms, however imperfectly, to the example set by Jesus of Nazareth.

What I urge is, that the natural philosopher is bound to consider such a life as not contingent upon a certain belief, or the acceptance of certain dogmas, or upon any one historical event, but that it has been possible to man in all ages, and is more possible now than it was in the time of Socrates, only by virtue of the force of the teachings, and of the immortal example of the founder of Christianity.

To the impartial observer such a man as Julian the Apostate appears as about the best Christian of his time, although he utterly abjured Christianity, and was a pagan to the last drop of his blood. To be a Christian, in the higher sense, is to live a certain life, not to subscribe to a certain creed; or, in the words of Milton (though Milton would probably have repudiated this application of his words), it is to "dare to think, to speak, and to be that which the highest wisdom has in every age taught to be best."

It may not be amiss for me to supplement or qualify the foregoing pages with a page or two which have a different bearing. In the first place, let me say that I have not so much spoken for myself therein as I have spoken for that attitude of mind which makes science or exact knowledge possible—a state of mind which, in our time, I am aware, is carrying things with a high hand. I know full well that science does not make up the sum-total of life; that there are many things in this world that count for more than exact knowledge. A noble sentiment, an heroic impulse, courage, and self-sacrifice—how all your exact demonstrations pale before these things! But I recognize the fact that within its own sphere science is supreme, and its sphere is commensurate with human reason; and that, when an appeal is made to it, we must abide by the result. Theology assumes to be a science, the science of God, and as such the evidence, the proof upon which it relies, must stand the test of reason, or be capable of verification. Religion, as a sentiment, as an aspiration after the highest

good, is one thing; but, formulated into a system of theology and assuming to rest upon exact demonstration, is quite another. As such it is exposed to the terrible question, Is it true? In other words, it comes within the range of science, and must stand its fire. When miracles are brought forward as an evidence of the truth of Christianity, the natural philosopher is bound to ask, Do miracles take place?

If our life were alone made up of reason or of exact knowledge, science would be all in all to us. So far as it is made up of these things, science must be our guide. But probably four fifths of life is quite outside of the sphere of science; four fifths of life is sentiment. The great ages of the world have been ages of sentiment; the great literatures are the embodiments of sentiment. Patriotism is a sentiment; love, benevolence, admiration, worship, are all sentiments.

Man is a creature of emotions, of attractions, and intuitions, as well as of reason and calculation. Science can not deepen your love of country, or of home and family, or of honor or purity, or enhance your enjoyment of a great poem or work of art, or of an heroic act, or of the beauty of Nature, or quicken your religious impulses. To know is less than to love; to know the reason of things is less than to be quick to the call of duty. Unless we approach the Bible, or any of the sacred books of antiquity, or the great poems, or Nature itself—a bird, a flower, a tree—in other than the scientific spirit, the spirit whose aim is to express all values in the terms of the reason or the understanding, we shall miss the greatest good they hold for us. We are not to approach them in a spirit hostile to science, but with a willingness to accept what science can give, but knowing full well that there is a joy in things and an insight into them which science can never give. There is probably nothing in the Sermon on the Mount that appeals to our scientific faculties, yet there are things here by reason of which the world is vastly the gainer. Indeed, nearly all the recorded utterances of Christ rise into regions where science can not follow. "Take no thought of the body." "He that would save his life shall lose it." "Except ye become as little children, ye can not enter the kingdom of heaven," etc. These things are in almost flat contradiction of the precepts of science.

It may be noted that Christ turned away from or rebuked the more exact, skeptical mind that asked for a sign, that wanted proof of everything, and that his appeal was to the more simple, credulous, and enthusiastic. He chose his disciples from among this class, men of faith and emotion, not too much given to reasoning about things. In keeping with this course of action, nearly all his teachings were by parables. In fact, Christ was the highest type of the mystical, parable-loving, Oriental mind, as distinguished from the exact, science-loving, Occidental mind.

Let us not make the mistake of supposing that all truth is scientific truth, or that only those things are true and valuable which are capable

of verification by the reason or by experience. Truth has many phases, and reaches us through many channels. There is a phase of truth which is apprehended by what we call taste, as poetic truth, literary truth; another phase which is felt by the conscience, as moral truth; and still another, which addresses the soul as the highest spiritual and religious truths. All these are subjective truths, and may be said to be qualities of the mind, but they are just as real for all that as the objective truths of science. These latter are the result of a demonstration, but the former are a revelation in the strict sense. Such a poet as Wordsworth, such a writer as Emerson, speaks to a certain order of minds. In each case there is a truth which is colored by, or rather is the product of the man's idiosyncrasy. In science we demand a perfectly colorless, transparent medium; the personality of the man must be kept out of the work, but in poetry and in general literature the personality of the man is the chief factor. The same is true of the great religious teachers; they give us themselves. They communicate to us, in a measure, their own exalted spirituality. The Pauline theology, or the theology which has been deduced from the teachings of Paul, may not be true as a proposition in Euclid is true, but the sentiment which animated Paul, his religious fervor, his heroic devotion to a worthy cause, were true, were real, and this is stimulating and helpful. Shall we make meat and drink of sacred things? Shall we value the Bible only for its literal, outward truth? Convince me that the historical part of the Bible is not true, that it is a mere tissue of myths and superstitions, that none of those things fell out as there recorded; and yet the vital, essential truth of the Bible is untouched. Its morals, its ethics, its poetry are forever true. Its cosmology may be entirely unscientific, probably is so, but its power over the human heart and soul remains. Indeed, the Bible is the great deep of the religious sentiment, the primordial ocean. All other expressions of this sentiment are shallow and tame compared with the briny deep of the Hebrew Scriptures. What storms of conscience sweep over it; what upreaching, what mutterings of wrath, what tenderness and sublimity, what darkness and terror are in this book! What pearls of wisdom it holds, what gems of poetry! Verily, the Spirit of the Eternal moves upon it. Whether, then, there be a personal God or not, whether our aspirations after immortality are well founded or not, yet the Bible is such an expression of the awe, and reverence, and yearning of the human soul in the presence of the facts of life and death, and of the power and mystery of the world, as pales all other expression of these things; not a cool, calculated expression of it, but an emotional, religious expression of it. To demonstrate its divergence from science is nothing; from the religious aspirations of the soul it does not diverge.

What I wish to say, therefore, is that we are conscious of emotions and promptings that are of deeper birth than the reason, that we are capable of a satisfaction in the universe quite apart from our exact

knowledge of it, and that the religious sentiment of man belongs to this order of truths. This sentiment takes on various forms; the forms themselves are not true, but the sentiment is. To recur to my former illustration of the constellations—however fantastic the figures which the soul has pictured upon the fathomless dome, the stars *are* there; the religious impulse remains.

It is perhaps inevitable that systems should arise, that creeds should be formed, and that the name of science should be invoked in their behalf, but the wise man knows they are perishable, and that the instinct that gave them birth alone endures. What is the value of this instinct? It would be presumption for me to attempt to estimate it, or to hope to disclose its full significance. Its history is written in the various ethnic religions, often written in revolting forms and observances. But it tends more and more to purify itself, rises more and more toward the conception of the fact that the kingdom of heaven is within and not without; and this purification has, in our day, unquestionably been forwarded by what we call science.

## ZOÖLOGICAL SUPERSTITIONS.

By FELIX L. OSWALD, M. D.

POPULAR sciences resemble the forest-plants that can flourish without the aid of systematic culture, but that advantage is offset by their liability to excrescences in the form of popular superstitions. During the middle ages thaumaturgy, or the study of the supernatural, enjoyed for centuries an all but universal popularity, and the luxuriance of its products almost suffocated all better germs of the human mind. For, by a curious law of primogeniture, the vitality of such spontaneous sprouts far exceeds that of the most carefully grafted scions. In natural history, for instance, many brilliant theories have appeared and disappeared like meteors, while popular delusions flicker with the persistency of a blazing tar-barrel.

The authority of Scripture (1 Kings, x, 22) warrants the belief that monkeys formed an article of commerce as much as twenty-eight centuries ago, so that no lack of time can have prevented us from studying the habits of our four-handed relatives; yet it would hardly be an overestimate to say that nine hundred and ninety-nine of a thousand men persist in the belief that monkeys have a passion for imitating the actions of their two-handed kinsmen; that, for instance, an ape, seeing his master shave himself, would take the first opportunity to get hold of a razor and scrape or cut his own throat. Now, how could that idea ever survive this age of zoölogical gardens? Marcus Aurelius held that the sum of all ethics was the rule to "love truth and justice, and live without anger, in the midst of lying and unjust men."

Yet the occupation of a monkey-trainer would put that tolerance to a severe test. With an intelligence surpassing that of the most intelligent dog, a monkey combines an ultra-mulish degree of obstinacy, and, rather than imitate the demonstrative manipulations of the kindest instructor, he will sham fear, sham lameness, sham heart-disease, and generally wind up by falling down in a sham fit of epileptic convulsions. I have owned monkeys of at least twenty different species, and have never been able to discover the slightest trace of that supposed *penchant* for mimicry. A boy may take off his coat and turn a thousand somersets, Jacko will watch the phenomenon only with a view to getting his fingers into the pockets of the unguarded coat. Lift up your hand a hundred times, Jacko will witness the proceeding with calm indifference, unless a more emphatic repetition of the manœuvre should make him duck his head to dodge an anticipated blow. He has no desire to follow any human precedents whatever, and the apparent exceptions from that rule are, on his part, wholly unintentional and merely a natural result of anatomical analogies. An angry hamadryas baboon, for instance, will strike the ground with his fist, not because any Christian visitors have ever set him that bad example, but because his forefathers have thus for ages vented their wrath on the rocks of the Nubian highlands. A capuchin monkey will pick huckleberries with his fingers, not in deference to civilized customs, but because his fingers are deft and long, and his jaws very short. Nay, that same capuchin monkey, admitted to a seat at the breakfast-table of a punctilious family, would be apt to show his contempt of court by sticking his head in the pudding-dish. The compulsive methods of professional trainers may modify that perversity, but during recess the redeemed four-hander is sure to drop his mask, and, unlike a trained dog, will never volunteer the performance of a popular trick.

About the beginning of this century an ingenious Frenchman traveled about with a so-called chess-automaton, a wooden figure with movable arms, manipulated by a hidden accomplice, and warranted to play chess according to the rules of Devega's manual. As a mystifying joke, the contrivance was quite a success, and, if any intelligent person could really believe in the autonomy of the apparatus, the silliness of the idea could hardly have surpassed the absurdity of the parrot-stories which our popular family journals continue to retail in this age of reason. Not more than a year ago, some modern Buffon, after a learned disquisition on the comparative intelligence of beasts and birds, treated his readers to the following "characteristic" anecdote: A Philadelphia family bought a parrot which could sing four or five national hymns, but to the dismay of his Quaker proprietor proved to have a still greater genius for blasphemous slang. Family worship and the conversation of learned and pious visitors were apt to be interrupted by a sudden cataract of Billingsgate, till the head of the family ordered the bird, at the first sign of profanity, to be ducked in

a pailful of cold water. The specific answered its purpose, and one rainy day the parrot was sitting in the open kitchen-window, watching the events of the back yard, where he espied a number of drenched chickens, picking their way across the slippery pavement. "Poor things!" said Polly, and then in an undertone, as the chickens approached the house—"Look here, you've been swearing, haven't you?" This probable story made the rounds of the American press, and is a fair sample of hundreds of similar myths. The truth is, that the wisest parrot ever shipped from Pará to New York does not connect the slightest meaning with the best-remembered word of his vocabulary. Properly speaking, elocutionary birds do not *talk* at all. They only repeat. They rehearse phrases as they would rehearse a tune, and one might as well credit a telephone with the ability of originating a logical combination of words. If profanity is a sin, swearing parrots will be forgiven, because they know not what they do; but their jokes are equally unintended. A phrase, repeated a thousand times a day, can not, of course, be used *always* malapropos, but the rarity of the exceptions confirms the rule as decidedly as the lucid interval of a Salvation Army dragoon. In one of Anderson's fairy-tales, the night wind tries to reveal a secret to a man who happens to understand only the dialect of his native village, and thus hears nothing but the whistling of the reeds and the rustling of the leaves; and in the wisest human speech poor Poll hears only the hooting of vowels and the clacking of consonants.

The serpent-charm superstition, too, still holds its own, though a recent communication to the "Scientific American" seems to imply that at least one common-sense explanation of the phenomenon begins to elucidate the fog of mysticism. The writer, evidently a practical naturalist, suggests that the apparent infatuation of "charmed" birds may be nothing but the heroism of maternal affection, overcoming the instinct of self-preservation. That inference may not rarely hold good in the spring-time of our northern woodlands, but squirrels and lizards, as well as birds, are charmed, and in October as often as in May; and the champions of the wizard-theory might at any time test the matter by a simple experiment. Venomous serpents are the most sluggish of all reptiles (compare "Popular Science Monthly," September, 1879), and, with a bag-net fastened to a ring and tied to the end of a long stick, a rattlesnake can be captured more easily than a butterfly. Quarter your captive in a convenient out-house and let him starve for a couple of days. Then procure a lot of rats, or good-sized mice, such as every mill-boy is ready to deliver for a dime a dozen. Do not introduce them all at once, but successively, and fastened to a string at the end of a stick. The apathy of the snake can be broken by making the mouse scamper in tempting proximity to his fangs. Give the poison time to operate, and watch the conduct of the victims; but observe the precaution of removing them just as the serpent approaches

to enjoy the fruits of her victory. The next time she will commence hostilities with a promptness evincing her wrath at the failure of her former attempts. Some five or six successive encounters (though each following discharge of poison may in some degree weaken the effect of the next bite) will thus prove that the supposed magic influence of the serpent's eye is nothing but the after-effect of a not strictly instantaneous poison. The flexible poison-fangs of the serpent do not enable her to hold her prey at the first snap, but she can afford to bide her time, well knowing that the beginning of the end is only a question of a few minutes. During the last of those minutes the victims may behave in a most singular, though under the circumstances noways abnormal, manner; and I will agree to sign Jean Bodin's dissertation on the disadvantages of natural explanations, if any thaumaturgist, with a lingering vestige of common sense, should fail to admit the conclusiveness of the experiment.

The serpent-charm delusion is probably nothing but an outcome of the evil-eye superstition, which in mediæval Italy ranked almost as an article of faith. In the same country poison-mongery had then attained the perfection of an exact science. In Naples there were experts who could specify the day when a tincture of *Aqua tofana*, repeated in a certain number of doses, would overcome the vitality of the toughest constitution. Cæsar Borgia could fetch his man by a mere scratch of a finger-ring. Many of those artists may have studied the subsequent appearance of their victims with a searching look, more apt to attract attention than the furtive administration of the deadly drug. If the victim died, his fate was ascribed to the influence of the *mal occhio*, a mystic gift which made its possessor an object of dread and envy, but of which the law could not properly take cognizance. The snap-bite, administered perhaps in the tangle of a bramble-bush, has escaped attention; the temporary escape of the victim obliges the serpent to sally from its hiding-place and watch the effect of the dose. At that stage of proceedings the conduct, both of the bird and the snake, is apt to attract the notice of a passer-by, who associates the then visible phenomena—the fixed gaze of the serpent, and the abnormal motions of the bird—thus mistaking a coincident circumstance for the cause of an effect.

Exactly the same mistake has cost the lives of thousands of harmless birds of the family *Picidæ*. Woodpeckers live upon the larvæ of various species of noxious insects, and haunt dead trees where such insects most abound: hence the extremely prevalent delusion connecting the activity of woodpeckers with the decay of trees. In the language of the backwoodsmen the tree-cleaner has become a tree-destroyer, a "sap-sucker," a name actually applied to the *Picus pubescens*, or speckled woodpecker, of the North American forests.

In a similar way the beneficent functions of the bat are still repaid with the ingratitude of the chief beneficiary. Bats catch mosquitoes,

bats catch night-butterflies, the parents of millions of noxious caterpillars, but, in default of a convenient cave, are apt to make their headquarters in smoke-stacks, and thus incur the suspicion of bacon-curing housewives:

"Bat, bat, fly in my hat,
And I'll give you some bacon-fat,"

is the popular stanza, preluding a shower of whistling brickbats, if the poor cheiropter ventures to leave his den before dark. And yet the *bona fide* petting of bats would, in many countries, be the best remedy of the mosquito-plague. There are few parts of Eastern Arkansas where the utmost diligence in ditching and draining would abate the torment of the perennial gnat-swarms, and in many swamp-districts of Southern Mexico one might as well try to bar out rats with a rail-fence as gnats with a mosquito-bar, since the forty or fifty different varieties comprise several sizes that could slip through the meshes of a cambric handkerchief, while the largest kind would as easily bite through a flannel night-shirt. Yet in the midst of such a swamp-delta I once passed a comfortable night in the loft of an old cotton-mill. We had neither gauze-bars nor smoke-pots, but two large *louvres* at opposite ends of the loft stood wide open, and all night the whispering of the land-breeze mingled with the fluttering and the clicking chirp of busy bats, but rarely as much as the incipient buzz of a tipulary insect.

The tenacity of the most preposterous tenets, as compared with that of less irrational delusions, is curiously illustrated by two zoölogical superstitions which North America seems to have imported from the northern nations of the Old World. A hundred years ago nine out of ten American colonists believed firmly in the existence of two remarkable vertebrates: the "joint-snake," a reptile gifted with the faculty of joining and disjoining its organism like a combination pen-holder; and the "glutton," a "monstre able to devore the carcaes of black cattle," as Sir Douglas of Glastonbury informs us.

The latter superstition has been traced to a singular international origin. The Norwegian *Fjell-frit*, or mountain-whelp, was mistaken for a *Viel-frass* by the same nation that turned a reindeer into a Rennthier ("race-beast"), and this incorrect "much-eater" was correctly translated into a French *glouton* and an English glutton, which the Latinizers, with their *penchant* for "characteristics," specified as a *gulo luscus*, just as the wolf-fish, or sea-cat of the Scotch fishermen, was made an *anarrhichas*, from a supposed dexterity in climbing rocks by means of its jagged fins. Encouraged by a solecism thus well indorsed, the first glutton-hunters of our continent reveled in miracle-legends.

"The Western trappers," says Colonel Ruxton ("Adventures in Mexico and the Rocky Mountains," page 278), "give most wonderful

accounts of an animal which, though exceedingly rare, is occasionally met with in the mountains, but, from its supposed ferocity and the fact of its being a cross between the devil and a bear, is given a wide berth whenever it makes its dreaded appearance. Most startling stories were told of its audacity: how it has been known to leap upon a hunter and devour him in a twinkling; often charging furiously into a camp and playing all sorts of pranks on the goods and chattels of the mountaineers. The general belief was, that the animal owes its paternity to the old gentleman himself; the most reasonable declaring it to be a cross between the bear and wolf. Hunting one day with an old Canadian trapper, he told me that, in a part of the mountains which we were about to visit, his comrades once had a battle with a 'carcagieu,' which lasted upward of two hours, during which they fired a pouchful of balls into the animal's body, which spat them out as fast as they were shot in! Two days after, as we were toiling up a steep ridge after a band of mountain-sheep, my companion, who was in advance, suddenly threw himself flat behind a rock and exclaimed in a smothered tone, signaling me with his hand to keep down and conceal myself, 'Sacré enfant de Gârce, mais here's von dam carcagieu!' I immediately cocked my rifle, and, advancing to the rock and peeping over it, saw an animal, about the size of a large badger, engaged in scraping up the earth about a dozen paces from where we were concealed. From its appearance I at once recognized the mysterious quadruped to be a 'glutton.' After I had sufficiently examined the animal, I raised my rifle to shoot, when a louder than common 'Enfant de Gârce!' alarmed the animal, and it immediately ran off, when I stood up and fired both barrels after it, but without effect, the attempt exciting a derisive laugh from the Canadian, who exclaimed: 'Pe gar, may be you got fifty balls; vel, shoot 'em all at de dam carcagieu, and he not care a dam!'"

But, after all, the foundation dogma, the existence of a wolf-like animal of prodigious voracity, was less insane than incorrect, and as such was renounced without regret. The joint-snake idiocy, on the other hand, though knocked to pieces a hundred times, persists in reviving with symbolic promptitude. In the Rocky Mountains, on the lower Mississippi, and all through the southern Alleghanies, farmers and hunters still believe in the self-reconstructive power of a reptile that survives dismemberment with the facility of a New York tramway ring, and, after picking up a jaw-bone here and a couple of vertebræ there, pursues its way rejoicing, and ready to segregate again at a minute's notice. Time-honored dogmas are ridicule-proof; and how shall we, in this special case, avail ourselves of Schopenhauer's maxim that the best way of refuting a superstition is to explain it? Should the strange delusion be founded on the habit of certain ophidians that make the pit of their œsophagus a place of refuge for their new-born offspring? Dozens of young snakelets have been seen crawl-

ing into the open jaws of the *Cerastes berus* and the *Clotho arietas*, and, according to Burmeister, also of certain pythons. But more probably the superstition is nothing but a product of that myth-making faculty that evolves a queer egg into a basilisk, and supplements a strange death by a still stranger resurrection. A correspondent of "Home and Farm" describes a number of brittle snakes and invertebrate snake-like worms "as easily broken as tallow-candles, *and about as hard to mend.*" Lizards, too, break at the mere touch of a switch and scamper off, leaving a tail-end wriggling in the grass. In some phenomenon of that sort the wonder-mania of our miracle-fuddled ancestors may have seen a glorious chance for insulting common sense by the elaboration of the joint-snake myth.

## THE HIGHER EDUCATION OF WOMAN.

By Mrs. E. LYNN LINTON.

ON all sides the woman question bristles with difficulties, and the higher education is one of them. The excess of women over men—reaching to not far from a million—makes it impossible for all to be married—Mormonism not being our way out of the wood. At the same time, this paucity of husbands necessitates the power of self-support for those women of the unendowed classes who are left penniless on the death of the bread-winner, and who must work if they would eat. This power of self-support, again, must be based on broad and honorable lines, and must include something that the world really wants and is content to pay for. It must not be a kind of well-masked charity if it is to serve the daughters of the professional class—women who are emphatically gentle, not only by birth, but by that refinement of habit and delicacy of sentiment which give the only true claim to the comprehensive term of lady. These women must be able to do something which shall not lower their social status and which shall give them a decent income. They must keep in line with their fathers and brothers, and be as well-considered as they. Certainly, they have always had the office of teachers; but all can not be schoolmistresses or governesses, and the continual addition made to the number of candidates for work demands, and has already opened, other avenues and fresh careers. And—but on this no one can help save women themselves—as teachers and governesses they are not generally treated as on an equality with their employers, and are made to feel that to gain money, even by their brains, lowers their social status and reduces them perilously near to the level of the servants. As authoresses or artists they may hold their own; the glamour of "fame" and "genius" gilding over the fact that they make their incomes and do not draw them, and have nothing capitalized—not even their own reputations.

Of late years this question of woman's work has passed into another phase, and the crux now is, not so much how they can be provided with work adequately remunerated, but how they can fit themselves for doing it without damage to their health and those interests of the race and society which are bound up with their well-being. This is the real difficulty, both of the higher education and of the general circumstances surrounding the self-support of women. For the strain is severe, and must be, if they are to successfully compete with men—undeniably the stronger, both in mind and body, in intellectual grasp and staying power, in the faculty of origination, the capacity for sustained effort, and in patient perseverance under arduous and it may be distasteful labor. But the dream and the chief endeavor of women now is to do the same work as men alone have hitherto done—which means that the weaker shall come into direct competition with the stronger—the result being surely a foregone conclusion. This is the natural consequence of the degradation by women themselves of their own more fitting work; so that a female doctor, for the present, holds a higher social position than does the resident governess, while a telegraph-girl may be a lady, but a shop-girl can not.

For well-paid intellectual work a good education is naturally of the first necessity, and the base on which all the rest is founded. Wherefore, the higher education has been organized more as a practical equipment than as an outcome of the purely intellectual desire of women to learn where they have nothing to gain by it. For all this, many girls go to Girton and Newnham who do not mean to practically profit by their education—girls who want to escape from the narrow limits of the home, and who yearn after the quasi-independence of college-life—girls to whom the unknown is emphatically the magnificent, and who desire novelty before all things; with the remnant of the purely studious—those who love learning for its own sake only, independent of gain, *kudos*, freedom, or novelty. But these are the women who would have studied as ardently, and with less strain, in their own homes; who would have taken a longer time over their education, and would not have hurt their health and drained their vital energies by doing in two or three years what should have taken five or six; who would have gathered with more deliberation, not spurred by emulation nor driven by competition; and who, with energy superadded to their love of knowledge, would have made the Mrs. Somervilles or Caroline Herschels, the Miss Burneys or Harriet Martineaus, of history. But such women are not many; voluntary devotion, irrespective of self-interest, to art, literature, science, philosophy, being one of the rarest accidents in the history of women—as, indeed, must needs be if they are to fulfill the natural functions of their sex.

Three important points come into this question of the higher education of women. These are—1. The wisdom or unwisdom for a father of limited means and uncapitalized income to send to college,

at great expense, girls who may marry, and so render the whole outlay of no avail. 2. The effect which this higher education has on the woman and the individual. 3. The physical results on her health and strength, especially in relation to her probable maternity.

To give a good education to a boy is to lay the foundations, not only for a successful individual life, but also those for a well-conditioned family. It is the only thing a man can do who has no fortune to leave his son, and is, in fact, a fortune under another form. With a good education, and brains to profit by it, nothing is impossible. From the Prime Minister to the Lord Chancellor, from the Archbishop of York to the leader of the House of Commons, a clever lad, well educated, has all professional possibilities before him—as the French private has the marshal's *bâton* in his knapsack. But to go to the like expense for the education of a daughter is by no means the same investment, nor can it be made to produce the same return. Where the man's education enables him to provide for his family, a woman's may be entirely thrown away for all remunerative results to herself and others. Indeed, it may be hurtful rather than beneficial. At the best—taking things by their rule and not by their exceptions—it is helpful to herself only; for the women of the professional class, like those of the laboring, support only themselves. For which cause, we may say parenthetically, they are able to undercut the men, and can afford to work for less than can those who have wives and children to support. And this is the reason—again parenthetically—why men try to keep them out of certain trades; seeing in them not so much honest competitors for so much work, as the ultimate destroyers of the home and the family itself. In the education, too, of his sons a father discriminates and determines according to their future. The boy intended for commerce he does not usually send to college; nor is stress laid on Latin or Greek or art or literature at school. For the one destined to the law or the church he stipulates for a sound classical training, and ultimately sends him to the university. For the artist he does not demand science; for the engineer he does not demand music—and so on. Almost all boys who have their own way to make are educated with a distinct reference to their future work; and wise men agree on the folly of wasting time and force on useless acquirements, with corresponding neglect of those which are useful. But how can girls be educated in this special manner? What professions are open to them as to men? The medical alone of the three learned, public opinion not yet being ripe for barristers in petticoats or for women preachers regularly ordained and beneficed; while the army and navy are still more closely shut against those ambitious amazons who think there should be no barriers against them in the barrack-yard or on the quarter-deck, and that what any individual woman can do she should be allowed to do, general rules of prohibition notwithstanding. The higher education gives us better teachers, more accurate writers, and

our scantling of medical women. But, if a girl is not to be one of these three things, the money spent on her college career will be emphatically wasted, so far as relates to the wise employment of funds in reference to a remunerative future.

And then there is always that chance of marriage, which knocks the whole thing to pieces; save in those exceptional cases where two students unite their brains as well as their fortunes, and the masculine M. A. marries the feminine, for the better perfecting of philosophic literature. Even in this rare instance the fact of marriage nullifies the good of the education; and, after a father has spent on his daughter's education the same amount of money as would have secured the fortune of a capable son, it can not give him retrospective satisfaction to see her married to some one who will make her the mother of a family, where nothing that she has gained at so much cost will tell. Her knowledge of Greek and German will not help her to understand the management of a nursery; nor will her ability to solve all the problems of Euclid teach her to solve that ass's bridge of domestic economy—the co-ordination of expenditure with means, and the best way of extracting the square root of refinement out of that appalling $x$ of insufficiency.

To justify the cost of her education a woman ought to devote herself to its use, else does it come under the head of waste; and to devote herself to its use she ought to make herself celibate by philosophy and for the utilization of her material, as nuns are celibate by religion and for the saving of their souls. As things are, it is a running with the hare of self-support and hunting with the hounds of matrimony—a kind of trusting to chance and waiting on the chapter of accidents, which deprives this higher education of anything like noble stability in results, making it a mere cast of the die which may draw a prize or throw blank. But very few women would elect to renounce their hope of marriage and maternity for the sake of utilizing their education, or would voluntarily subordinate their individual desire to that vague thing, the good of society. On this point I shall have something to say further on. Yet this self-dedication would be the best answer to those who object to the higher education for the daughters of struggling professional men, because of the large chance there is of its ultimate uselessness. It would give, too, a social purpose, a moral dignity, a philosophic purity, and a personal earnestness to the whole scheme which would make it solid and organic, instead of, as now, loose and accidental.

So far as we have yet gone, has this higher education had a supremely beneficial effect on the character of women themselves? As intelligences, yes; as women, doubtful. We are not now taking the individual women who have been to Girton or Newnham, but the whole class of the quite modern advanced women. These are the direct product of the movement which has not only given us female doctors

and superior teachers, but female orators, female politicians, and female censors all round—women who claim for themselves the leadership of life on the ground of a superior morality and clearer insight than have men. In dealing with the woman question, we can never forget the prominent characteristics of the sex—their moral vanity, coupled with their love of domination. The great mass of women think they know better than they can be taught; and on all moral questions claim the highest direction and the noblest spiritual enlightenment. Judging from sentiment and feeling, they refuse the testimony of facts; the logic of history has no lesson for them, nor has any unwelcome science its rights or its truths. They are Anglo-Israelites, but not the products of evolution; and ghosts are real where germs are imaginary. This sentiment, this feeling, is like some other things, a good servant but a bad master. When backed by religious faith it stops at no superstition; when backed by moral conviction, it is a tyranny under which the free energies of life are rendered impossible; when backed by a little knowledge, it assumes infallibility. Scarcely a week passes without some letter in the papers, wherein an imperfectly educated woman attacks a master in his profession, on the ground of her sentiment as superior to his facts—her spiritual enlightenment the Aaron's rod which swallows up his inferior little serpents of scientific truths. This restless desire to shoot with all bows—Ulysses', Nestor's, whose one will—may be, and probably is, the first effervescence of a ferment which will work itself clear by time and use. It is to be hoped so; for the pretensions to supremacy, by reason of their superiority, of women in these later times is not one of the most satisfactory results of the emancipation movement. And they can not be too often reminded that the higher education, with all that this includes, is not meant to supersede their beautiful qualities, but only to strengthen their weak intellectual places and supply their mental deficiencies.

It would not be for the good of the world were the sentiment and tenderness of women to be lost in their philosophic calmness. But as little is it for the advantage of society when that sentiment rules rather than influences, shapes rather than modifies. That old adage about two riding on horseback together, when one must ride behind, is getting a new illustration. Hitherto the man was in front. It was thought that he was the better fitted to both discern the dangers ahead and receive the first brunt of such blows as might be about, while the woman crouched behind the shield of his broad body; and in return for that protection left the reins in his hands and did not meddle with the whip—or if she did, then was she censured while he was ridiculed. Now, things are changing; and on all sides women are seeking to dispossess the men of their places to take them for themselves. In the home and out of the home woman's main desire is for recognized leadership, so that man shall live by their rule. The bed

of Procrustes was no myth; we have it in full working activity at this present time.

We come now to the third and most important point, the physical results of the educational strain in relation to maternity. On this head we will take Dr. Withers-Moore as our guide, in his speech made at the British Association on the 11th of August. The pith of his position is in this sentence, "Bacon's mother (intellectual as she was) could not have produced the 'Novum Organum,' but she, perhaps she alone, could and did produce Bacon." The same may be said of Goethe's mother. She could not have written "Faust," but she formed and molded and influenced the man who did. In almost all the histories of great men it is the mother, and not the father, whose influence and teaching are directly traceable; and it is a remark as trite as the thing is common, that great men do not often produce great sons, but almost all great men have notable mothers. As the "Oxford tutor," quoted by Dr. Withers-Moore, said, "A man's fate depends on the nursing—on the mother, not the father. The father has commonly little to do with the boy till the bent is given, and the foundation of character laid. All depends on the mother." And this means not only her moral influence, but the actual shaping and molding force of her physical condition reacting on his. Following this are the opinions of experts and philosophers who have given time and thought to the subject; and in all the authorities quoted—fourteen in number—there is the same note of warning against overstudy in girls who are one day to be mothers. It is an unwelcome doctrine to those who desire above all things to be put on an absolute equality with men; who desire to do man's special work, while leaving undone their own; who will not recognize the limitations of sex nor the barriers of Nature; who shut their eyes to the good of society and the evil which may be done by individuals; and who believe that all who would arrest a movement fraught with danger to the whole are actuated by private motives of a base kind, and are to be treated as enemies willfully seeking to injure, rather than as friends earnestly desirous of averting injury. Dr. Withers-Moore's summary of the whole question bearing on the physical condition of women as mothers is this:

> Excessive work, especially in youth, is ruinous to health, both of mind and body; excessive brain-work more surely so than any other. From the eagerness of woman's nature, competitive brain-work among gifted girls can hardly but be excessive, especially if the competition be against the superior brain-weight and brain-strength of man. The resulting ruin can be averted—if it be averted at all—only by drawing so largely upon the woman's whole capital stock of vital force and energy as to leave a remainder quite inadequate for maternity. The Laureate's "sweet girl graduate in her golden hair" will not have in her the fulfillment of his later aspiration—
>
> "May we see, as ages run,
> The mother featured in the son."

The human race will have lost those who should have been her sons. Bacon,

for want of a mother, will not be born. She who should have been his mother will perhaps be a very distinguished collegian. That one truism says it all—women are made and meant to be, not men, but mothers of men. A noble mother, a noble wife—are not these the designations in which we find the highest ideal of noble womanhood? Woman was formed to be man's helpmate, not his rival; heart, not head; sustainer, not leader.

The ideal mother is undoubtedly a woman more placid than nervous in temperament, more energetic than restless in habits, and with more strength of character and general good sense than specialized intellectual acquirements. Strong emotions, strained nerves, excitement, anxiety, absorption, are all hurtful to the unborn child. They tend to bring on premature birth; and if not this, then they create sickly offspring, whom the mother can not nourish when they are born. And, speaking of this, I may as well state here that the number of women who can not nurse their own children is yearly increasing in the educated and well-conditioned classes; and that coincident with this special failure is the increase of uterine disease. This I have from one of our most famous specialists. The mental worries and the strain of attention inseparable from professional life make the worst possible conditions for satisfactory child-bearing; while the anxiety bound up with the interruption to her work, consequent on her health and changed condition, must tell heavily on the nerves and mind of the woman whose professional income counts in the family. Her physical troubles, of themselves quite enough to bear, have thus extra weight; and mind, nerves, work, and condition, act and react in a vicious circle all round. Even where her profession is one that does not take her out-of-doors, and does not involve any great personal fatigue—as literature or art—the anxiety of her work and the interruption which must needs result from her state are more disastrous to the unborn than to herself; and the child suffers as much from the relaxation as from the strain. As one of the wisest and best-trained women I know said to me the other day: "How much of all the grand force and nervous power, the steadiness and courage of Englishmen, may not be owing to the fact of the home-life and protection of women; and how much shall we not lose when the mothers of the race are rendered nervous, irritable, and overstrained by the exciting stimulus of education carried to excess, and the exhausting anxieties of professional competition!"

This does not say that only the "stupid women" are therefore to be wives and mothers. Specialized education does not necessarily create companionable nor even sensible women; else, by parity of reasoning, would all professional men be personally charming and delightful, which undoubtedly they all are not. A girl may be a sound Grecian, a brilliant mathematician, a sharp critic, a faultless grammarian, yet be wanting in all that personal tact and temper, clear observation, ready sympathy, and noble self-control which make a companionable wife and a valuable mother. Nor is unprofessional or unspecialized

instruction necessarily synonymous with idleness and ignorance; while a good all-round education is likely to prove more serviceable in the home and in society than one or two supreme accomplishments. Many of us make the mistake of confounding education with acquirements, and of running together mental development and intellectual specialization. The women of whom we are most proud in our own history were not remarkable for special intellectual acquirements so much as for general character and the harmonious working of will and morality. The Lady Fanshawes and Elizabeth Frys, the Mary Carpenters and Florence Nightingales, whose names are practically immortal, were not noted for their learning, but they were none the less women whose mark in history is indelible, and the good they did lives after them, and will never die. And taking one of the, at least, partially learned ladies of the past—is it her Latinity and her bookishness that we admire so much in Lady Jane Grey; or is it her modesty, her gentleness, her saintly patience, her devotion?—in a word, is it her education or her character?—the intellectual philosopher, or the sweet and lovely and noble woman?

Modern men want intelligent companions in their wives. But the race demands in its turn healthy, wise, and noble mothers of vigorous children. Only a few of the less worthy men desire simply an upper servant for domestic use, or a mistress for personal pleasure, or both in one, with whom they, the husbands, feel no true comradeship. But do the mass of men want the specialized companionship of a like education? Does not human nature rather desire a change—the relaxation of differences?—and do specialists want to be always talking to their wives of literature, art, science, medicine, law—whatever may be their own assigned work? Would they not rather forget the shop, even though that shop be the library or the studio, and pass into a fresh intellectual atmosphere when they lay aside their MSS. or fling down their brushes? We must always remember, too, that the conduct and management of the house and family belong to women; and that, if the wife and mother does not actively superintend those departments which the fitness of things has apportioned to her, subordinates must—subordinates who will not put into their work either the love or the conscience of the wife, whose interests are identical with her husband's—of the mother, with whom reason and instinct, education and affection, create that half-divine power to which most great men have owed the chief part of their greatness.

Not going all the length of the Turkish idea that women are born into the world only to be the wives and mothers of men—as mothers of women simply keeping up the supply, and that for themselves they are of no account outside their usefulness to and relations with men—it is yet undeniably better that they should be unnoted as individuals and perfect as mothers, rather than famous in their own persons and the mothers of abortive and unsatisfactory children. In this lies the

soul of the controversy; for the whole question is contained in the relative importance of individual rights and social duties—freedom for self-development in such direction as may suit ourselves, or subordinating our personal desires to the general and unindividualized good.

We are in the midst of one of the great revolutions of the world. The old faiths are losing their hold and the new are not yet rooted; the old organization of society is crumbling to pieces and we have not even founded, still less created, the new. In this revolution, naturally one of the most prominent facts is the universal claim for individual freedom, outside the elemental laws which hold the foundations together, made by every one alike. We preach the doctrine of rights everywhere, that of duties straggles in where it can; and the one crying need of the world at this moment is for some wise and powerful organizer who shall recombine these scattered elements and reconstruct the shattered edifice. Women, who always outstrip their leaders, are more disorganized, because at this time they are even more individualized, than are men. Scarcely one among them takes into account the general good. Even in those questions where they have made themselves the leaders, individual victories are of greater value than general policy, and they would always subordinate the practical welfare of the majority to the sentimental rights of the minority. An individual sorrow moves them where the massed results of a general law leave them cold. This characteristic is perfectly sound and righteous in those to whom have been confided the care of the family and the arrangement of details. Women ought to be individual, not for themselves but for others; and in that individualism there ought to be the injustice inseparable from devotion. An altruistic mother who would sacrifice her one child for the sake of her neighbor's two does not exactly fulfill our ideas of maternal care; on the other hand, a mother who would rather her son was disgraced as a coward than that he should run the dangers of courage, or the partisan of her own sex who would sacrifice twenty men to save one woman inconvenience or displeasure, is as little fit to be the leader of large movements involving many and varied interests as is that other to be a mother. In their own persons women carry out to a very remarkable degree this principle of individualism, the general good notwithstanding. Speak to an ordinary woman of the evil economic effects of her actions, and you speak a foreign language. She sees only the individual loss or gain of the transaction, and a public or social duty to creatures unknown and unseen does not count. In the cruel vicissitudes of fashion and the ruin of thousands brought about by simple change of material—in the selfish greed for bargains, no matter at whose cost obtained—in the complete ignoring of and indifference to all the results to others of her own example, a woman of the ordinary type is essentially individual and unsocial. In America—whence, how-

ever, we have received so many grand and noble impulses—this female individualism, with its corresponding indifference to the public good or to public duty, is even more pronounced than here; and the right of woman to her own development, though that should include what is called "the painless extinction of man," is the very heart and soul of the new creed.

Women, seeking to rule, have forgotten how to obey. Wishing to reorganize society according to their own desires, they have at the same time thrown off all sense of discipline in their own lives; and the former feminine virtues of devotion, patience, self-suppression, and obedience are flung aside as so much tarnished finery of a decayed and dishonored idol. The ordinary woman can not be got to see that she is not only herself but also a member of society and part of an organization; and that she owes, as a duty to the community, the subordination of her individualism to that organization. She understands this only in religious communities, where she obeys her director as one divinely commissioned. Outside religious discipline she refuses obedience to general principles. Society has grown so large and its disorganization is so complete that, she says to herself, her own example does not count. She is but a fractional part of a grain added to a ton-weight; and by the law of psycho-dynamics she is undiscerned and without influence. It is all very well in small communities, like those of Greece for instance, or when the one grand lady of the village was the mirror for all to dress by. Then, the individual example was of value; but now—who cares for one out of the tens of thousands crowded in London; and what duty has she to the community comparable to that which she owes herself?

And this brings us round once more to the subject-matter of this paper—the effect on the community of the higher education of women, in its good and evil results on mothers and their offspring, and their own indifference to these results.

It is impossible not to sympathize with a bright girl anxious to go on with her education, and petitioning for leave to study higher matters than have been taught her at her school. It is as impossible not to feel a sense of indignation at the injustice when parents say frankly the education of their girls does not count with them; and, so long as these know how to read and write and can play the piano and are able to dance and perhaps to sew, there is nothing more necessary. We do battle then for the right of the individual to know, to learn, to perfect itself to the utmost of its ability, irrespective of sex. But if we are wise we stop short of such strain as would hurt the health and damage the reproductive energies, if marriage is to come into one of the chances of the future. A girl is something more than an individual; she is the potential mother of a race; and the last is greater and more important than the first. Let her learn by all means. Let her store her mind and add to her knowledge, but always with quietness and

self-control—always under restrictions bounded by her sex and its future possible function. Or, if she disregards these restrictions, and goes in for competitive examinations, with their exhausting strain and feverish excitement—if she takes up a profession where she will have to compete with men and suffer all the pain and anxiety of the unequal struggle—let her then dedicate herself from the beginning as the vestal of knowledge, and forego the exercise of that function the perfection of which her own self-improvement has destroyed. We can not combine opposites nor reconcile conflicting conditions. If the mental strain consequent on this higher education does waste the physical energies, and if the gain of the individual is loss to the race, then must that gain be sacrificed or isolated.

Of course, it all depends on that if; and of this experts are the only trustworthy judges. We must be guided by the better knowledge of specialists and those who have studied in all its bearings a subject of which we know only one side, and that side the one turned to our own desire. If one examiner * reports that "of the boys twenty-nine per cent, and of the girls forty-one per cent, were found to be in a sickly state of health"; if another, † in confirmation, says that "11·6 per cent of boys and girls in the St. Petersburg schools suffer from headache," we must suppose there is something to be taken note of in the opposition of most medical men to this higher education of women. For we must put out of court, as unworthy of serious consideration, that old, well-worn accusation of man's opposition to woman's advancement from jealousy, tyranny, the desire of domination, and the preference of slaves and mistresses over companions and wives. We must accept it as part of all sane argument that people desire the best—ideas as to what is the best differing according to the point of view; as now in this very question under consideration, where the individual gain clashes with the good of the community, and the personal advantage of the woman hurts her usefulness as a mother. We must acknowledge, too, that experts know better than the unlearned; and that, in matters of health and the wisest rules for physical well-being, medical men are safer guides than girls ambitious for their own distinction, or women ambitious for their sex—holders, too, of the doctrine of absolute equality in mental strength with men, and of free trade in all employments and careers.

A great deal of the difficulty surrounding the question of woman's employment could be got over by women themselves. If, instead of degrading their own more natural work by the social ostracism of the workers, they would raise it by respect and honor, large fields of productive usefulness would be opened and much cause for heart-burning would cease. The greater democracy of the present age makes it pos-

* Dr. Hertel, speaking of over-pressure in the high-schools of Denmark.

† Professor J. N. Bystroff. Both quoted by Dr. Withers-Moore in his speech at the British Association.

sible for great ladies to earn money. Even a queen throws her books into the market, and sells them all the same as others. A generation or so ago no lady could have made money, save by the two methods of painting and writing—both done within the sacred seclusion of the four walls of home. Actresses were what we call in the north "chancey." Some were thoroughly respectable, and came to good ends and high positions; but the bulk were best left alone by women who wished to keep alive anything like veneration for virtue. Now, however, we have opened all gateways, and made it possible for ladies of condition, repute, and birth to do what they will in the way of money-making and still retain both character and position. A princess opens a milliner's shop; a lady of rank is a cow-keeper and profits by her dairy-farm; women of title go on the stage; ladies of gentle birth and breeding are storekeepers and horse-breeders. But as yet these are only the showy —we had almost said theatrical—and quasi-romantic vanguard; and what we want is a stable condition of self-support for women whose inherited position is not of that high class which no work can degrade, but who, ladies as they are, stand or fall according to the arbitrary estimation of their work.

In this, we repeat, no one can help women save women. Certain tailors and certain shopkeepers are received in London society as among its favorite and most honored guests. Do we meet with a milliner, a lady shopkeeper? Do we not all know milliners and dressmakers who are well-educated, pleasant-mannered, honorable ladies; yet would the countesses and dames for whom they devise their dainty costumes agree to meet them on equal terms at balls and dinners? Why not? Surely it can not be on the ground of making their own money. The highest ladies in the land do not disdain to turn an honest penny if they can; and where, pray, is the essential difference between the clergyman's daughter who sells mantles or laces in a shop for her living and the young duchess who sells pincushions and button-holes at a bazaar for her vanity, masked as charity? Here, if we will, the principle of individualism would work with advantage. If we could get rid of all caste feeling, and judge of people by themselves and not by their work—if we would allow that a milliner could be a lady, and a shop-girl on a level with her sister the governess, and both on an equality with their brother the clergyman and their aunt the physician's wife—we should have done more for the question of the employment of women than we have done by the establishment of colleges and the creation of educational standards, the attainments of which are inimical to the best interests of society because hurtful to women themselves. We must do what we can in this life, not always what we would; and the general interests of society are to be considered before those of a special section, by whose advancement will come about the corresponding degeneracy of the majority.

In these two propositions, then, we think the whole thing lies—in

voluntary celibacy for those who overtax their vital energies by an intellectual strain that hurts the offspring; and in the honoring of those lighter and easier methods of making money which have hitherto condemned a woman to social ostracism, and denied her the status she deserves and has inherited.—*Fortnightly Review.*

## ENERGY IN PLANT-CELLS.

By Professor T. H. McBRIDE.

FEW people have any true conception either of the kind or amount of actual energy displayed in the life and growth of a simple plant. In ordinary experience the manifestations of vital energy are always associated with the activity of some animal. Life in the animal seems at its best; its forces are more concentrated, hence more vivid in display, and in every way appeal more certainly to our attention. An animal can move, can exhibit strength, can do work, hence has force, exhibits energy—vital energy, if you please. But in the plant-world these forces are less noted, although going on in much the same way to the accomplishment of life's purposes; and, if less obtrusive in their action and simpler in behavior, are also less difficult to study and easier to understand. To see where some of these forces are exerted, how they are manifested and how controlled, is, in so far as circumstances may allow, the purpose of this article.

The most patent display of energy on the part of a plant is in connection with the growth. Every one knows how a growing seed will send a shoot to the surface through a hard covering of overlying earth. And above-ground the tip of the growing plantlet persistently defies gravitation. Roots find their way through the interstices of clay, and crowd into the enlarging crevices of rocks. The bark of a tree, under tension, in equilibrium of pressure and resistance as long as the tree lives, evinces an energy very appreciable in amount. The amount of force concerned in this case we are not left to imagine, but may at least approximately estimate.

Along the highway that passes one of our Iowa farms were planted many years ago a row of soft-maple trees, designed to serve at length as posts for carrying the wires of the fence. When the trees attained suitable size they were put to the use intended by nailing to each tree a piece of pine lumber four feet long and two by four inches in section for the better attachment of the wires. Since the erection of the fence in the way indicated, the growth of the trees has produced some very striking results. The blocks were attached to the trees by heavy iron spikes (Fig. 1). These seem to have rusted into the tree, and by their points to have held firmly, while by the continual deposition of

new layers the tree has crowded off the block, drawing the head of the spike directly through the pine wood; that is, new material has been thrust in between the wood of the tree on the one hand and the block on the other, until the block has been fairly wedged from its place. Now, it is asserted on excellent authority that the force necessary to accomplish this result amounts to a pressure of about thirty pounds to the square inch; i. e., the forces of growth in a soft maple are capable of exerting in all directions a force of thirty pounds to the square inch. Now, these results may seem somewhat surprising, but our surprise is in no degree lessened when we begin to study the machinery by which this energy is exerted. If we could make a cross-section of one of the trees in question, we should find by far the greater part of the tree in a condition of nearly absolute fixity, incapable of enlargement in any direction. Outside is the bark, likewise largely incapable of exerting force, most of the cells having long since yielded up their living matter. Only on the line of division separating bark from wood do we find a structure whose cells are capable of life, growth, and multiplication. This structure is so thin that only the finest line would be needed for its delineation, were we to draw the whole section, natural size (Fig. 2). Furthermore, this layer is made of cells whose walls are exceedingly delicate and thin. So much more feeble, in this regard, are the cells here than on either side, that this layer, the cambium, is the line of separation when, in the growing season, you easily strip the green bark from the wood. The energy, then, which we have estimated, must finally rest upon these thin-walled, delicate cells. Not only is this true, but we may also easily conclude that all the pressure by which the cleat is wedged from the tree must come from the growth and multiplication of the same diminutive organisms. It is plain here that the force concerned is not capillary, for that is certainly as active in the woody parts of the tree as in the cambium, there producing no expansion whatever. Neither does it seem that the energy expended must be attributed to osmosis, although the cell may be by construc-

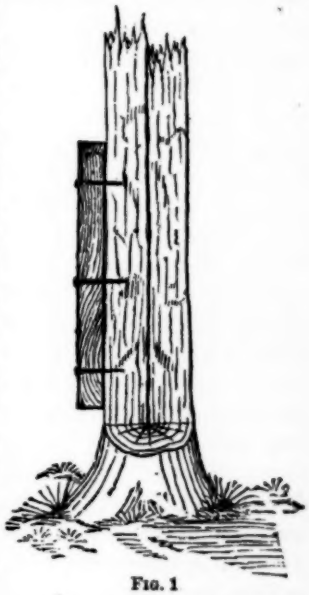


FIG. 1

FIG. 2.—CROSS-SECTION OF AN EXOGENOUS STEM.

tion a simple osmotic apparatus. Osmosis there undoubtedly is, but it is exactly similar here to osmosis everywhere, and, while accounting for certain things as capillarity accounts for certain other things, still does not mean growth. Let us see what osmosis can do. If two liquids of unequal density be separated by a membrane pervious to either or both, an interchange between the two fluids occurs until equilibrium of density is established, the greater quantity of the commingled fluids being found at last on that side of the membrame at first occupied by the denser fluid. Suppose now, for illustration, a chain of cells extending from some leaf on the maple-tree down to some rootlet in contact with a drop of water, each cell-content of less density than that above it, and we should have a current setting toward the leaf, and likewise, though less in energy and amount, a current in the opposite direction. Certainly, something of this kind actually happens, not in a single row of cells, but involving all active cells of the tree, so that water from the soil is carried to the leaf, and the products of the latter are diffused throughout the organism. We may even conceive the cells beneath our block of wood to be distended to repletion by the process just described, yet all this is not growth. Given this machinery at the beginning of our experiment, and we can see that the connection of the block would be strained as when wooden wedges, by absorbing water, burst the rock. But the cells once distended, the limit of pressure is reached, and everything would remain in *statu quo*. And now appears the energy of life's forces. After osmosis and diffusion have done their best, the living matter of the cell is able, notwithstanding the pressure, to enlarge the cells, increase their number, and thicken their walls, and this it is that at length produces the phenomenon we have seen, and brings the spikes, heads and all, through the yielding wood.

But let us look at another example illustrating this same thing. In the manufacture of beer, as every one knows, the alcohol of the beverage is produced by fermentation, a process induced through the activity of brewer's yeast. Now, brewer's yeast, as may be shown by any good microscope, consists essentially of minute single cells, each of which is capable of performing alone all vital functions ; i. e., each cell can assimilate food, grow, and reproduce its kind—the two functions last named being here, as elsewhere, dependent on the first. The food of the yeast-cell in this instance is grape-sugar or glucose. From this comes as a sort of by-product of assimilation carbon dioxide in large quantities. The liberation of this gas in the wort produces the frothing which constitutes so noticeable a feature of fermentation. The glucose being the source of supply whence the gas is eliminated, it is plain, all questions of temperature aside, that gas will appear so long as glucose remains in sufficient quantity to nourish the yeast. The amount of glucose found in different grades varies, but certain it is that no beer is entirely free from this yeast-food, so that, when the

brewer is ready to deliver his beer to the customer, he is painfully aware that his goods are in anything but stable condition. Hence beer for shipment is placed in oak quarter-barrels (kegs), bound with many broad iron hoops, and made by shape and in every way as stout and strong as possible. Prior to filling at the brewery, beer-kegs are subjected to water-pressure of thirty-five pounds to the square inch, and yet, notwithstanding care in construction and rigor in the test applied, beer-kegs will once in a while actually burst; i. e., the strain caused by internal pressure passes (probably far surpasses) the limit of the test. Here then, again, we have a gauge by which to estimate the energy of life's forces. The pressure is due to the evolution of gas; but the gas, as has been said, is disengaged only as a consequent of vitality, of growth, and, at the moment preceding the explosion, the cells are acting, the processes of growth accomplishing, under a pressure of not less than forty or fifty pounds to the inch. The yeast-cell grows, pushes forth bud after bud, liberates particle after particle of carbon dioxide, all under increasing pressure the further the process goes, until at last at the supreme moment oak and iron can endure no more—the barrel bursts! Here no one can quote osmosis, although as between the contents of the cell and the surrounding liquid osmosis doubtless there is, as there was in the case of the maple; but osmosis is certainly not responsible for the gas-pressure under which the cells are working.

The illustrations cited certainly establish the truth of the proposition with which we began, viz., that plant-cells may display actual appreciable energy. Indeed, it would seem that no one could look in upon the living streams of any transparent, active cell, as these sweep within narrow limits in tireless ebb and flow, and not be convinced that in some way at least life is the exponent of force. What that force may be, no one can positively as of knowledge say. If we affirm that the energy of the plant-cell is to be traced to the sun's rays, we state but a partial truth. The sunlight simply continues an energy already started, simply keeps the machinery wound up, or rather prevents its running down, and we can conceive of no cell whose primary energy is not derived directly from the nearest link of the infinite chain preceding.

Take now into consideration what we may call the directive energy of the cell (call it accumulated habit, hereditary endowment, or what you will), which determines the direction and the limits of the cell's growth, which locks within the compass of a single bit of protoplasm the destiny of millions of succeeding living atoms, combining to the accomplishment of most wonderful and varied functions, so that every germ-cell at the least has its own individuality, its own future, its own ideal, into which in the order of Nature it comes, and we begin to see that, even were the physical energies of the cell cleared up, we are yet as far off as ever from the solution of life's problem. As Emerson puts

it, "Life is life which *generates*," and generation implies an energy to which all other energy in a living cell yields homage.

In thus measuring the energy which cells exert, it seems to me we lay our finger on the very pulse of the living world; we *feel* the push of its ceaseless stream, and in the impact of the latest wave catch the full force of that primal impulse in which life's history on earth began.

## GEOLOGY OF THE ATLANTIC OCEAN.*

By Sir WILLIAM DAWSON,
PRINCIPAL OF McGILL COLLEGE, MONTREAL.

II.

THUS far our discussion has been limited almost entirely to physical causes and effects. If we now turn to the life-history of the Atlantic, we are met at the threshold with the question of climate, not as a thing fixed and immutable, but as changing from age to age in harmony with geographical mutations, and producing long cosmic summers and winters of alternate warmth and refrigeration. We can scarcely doubt that the close connection of the Atlantic and Arctic Oceans is one factor in those remarkable vicissitudes of climate experienced by the former, and in which the Pacific area has also shared in connection with the Antarctic Sea. No geological facts are indeed at first sight more strange and inexplicable than the changes of climate in the Atlantic area, even in comparatively modern periods. We know that in the early Tertiary perpetual summer reigned as far north as the middle of Greenland, and that in the Pleistocene the Arctic cold advanced until an almost perennial winter prevailed half-way to the equator.

It is no wonder that nearly every cause available in the heavens and the earth has been invoked to account for these astounding facts. It will, I hope, meet with the approval of your veteran glaciologist, Dr. Crosskey, if, neglecting most of these theoretical views, I venture to invite your attention in connection with this question chiefly to the old Lyellian doctrine of the modification of climate by geographical changes. Let us, at least, consider how much these are able to account for. The ocean is a great equalizer of extremes of temperature. It does this by its great capacity for heat and by its cooling and heating power when passing from the solid into the liquid and gaseous states, and the reverse. It also acts by its mobility, its currents serving to convey heat to great distances or to cool the air by the movement of cold, icy waters. The land, on the other hand, cools or warms rapidly, and can transmit its influence to a distance only

* From the inaugural address of the President of the British Association for the Advancement of Science, delivered at Birmingham, England, September 1, 1886.

by the winds, and the influence so transmitted is rather in the nature of a disturbing than of an equalizing cause. It follows that any change in the distribution of land and water must affect climate, more especially if it changes the character or course of the ocean-currents.

At the present time the North Atlantic presents some very peculiar and, in some respects, exceptional features, which are most instructive with reference to its past history. The great internal plateau of the American Continent is now dry land; the passage across Central America between the Atlantic and Pacific is blocked; the Atlantic opens very widely to the north; the high mass of Greenland towers in its northern part. The effects are that the great equatorial current running across from Africa and embayed in the Gulf of Mexico is thrown northward and eastward in the Gulf Stream, acting as a hot-water apparatus to heat up to an exceptional degree the western coast of Europe. On the other hand, the cold Arctic current from the polar seas is thrown to the westward, and runs down from Greenland past the American shore. The pilot chart for June of this year shows vast fields of drift-ice on the western side of the Atlantic as far south as the latitude of 40°. So far, therefore, the glacial age in that part of the Atlantic still extends; this at a time when, on the eastern side of the ocean, the culture of cereals reaches in Norway beyond the Arctic Circle.

Let us inquire into some of the details of these phenomena. The warm water thrown into the North Atlantic not only increases the temperature of its whole waters, but gives an exceptionally mild climate to Western Europe. Still, the countervailing influence of the Arctic currents and the Greenland ice is sufficient to permit icebergs which creep down to the mouth of the Strait of Belle Isle, in the latitude of the south of England, to remain unmelted till the snows of a succeeding winter fall upon them.

Now let us suppose that a subsidence of land in tropical America were to allow the equatorial current to pass through into the Pacific. The effect would at once be to reduce the temperature of Norway and Britain to that of Greenland and Labrador at present, while the latter countries would themselves become colder. The northern ice, drifting down into the Atlantic, would not, as now, be melted rapidly by the warm water which it meets in the Gulf Stream. Much larger quantities of it would remain undissolved in summer, and thus an accumulation of permanent ice would take place, along the American coast at first, but probably at length even on the European side. This would still further chill the atmosphere, glaciers would be established on all the mountains of temperate Europe and America, the summer would be kept cold by melting ice and snow, and at length all Eastern America and Europe might become uninhabitable, except by Arctic animals and plants as far south as, perhaps, 40° of north latitude.

This would be simply a return of the glacial age. I have assumed only one geographical change; but other and more complete changes of subsidence and elevation might take place, with effects on climate still more decisive; more especially would this be the case if there were a considerable submergence of the land in temperate latitudes.

We may suppose an opposite case. The high plateau of Greenland might subside or be reduced in height, and the openings of Baffin's Bay and the North Atlantic might be closed. At the same time the interior plain of America might be depressed, so that, as we know to have been the case in the Cretaceous period, the warm waters of the Mexican Gulf would circulate as far north as the basins of the present great American lakes. In these circumstances there would be an immense diminution of the sources of floating ice, and a correspondingly vast increase in the surface of warm water. The effects would be to enable a temperate flora to subsist in Greenland, and to bring all the present temperate regions of Europe and America into a condition of subtropical verdure.

It is only necessary to add that we know that vicissitudes not dissimilar from those above sketched have actually occurred in comparatively recent geological times, to enable us to perceive that we can dispense with all other causes of change of climate, though admitting that some of them may have occupied a secondary place. This will give us, in dealing with the distribution of life, the great advantage of not being tied up to definite astronomical cycles of glaciation, which may not always suit the geological facts, and of correlating elevation and subsidence of the land with changes of climate affecting living beings. It will, however, be necessary, as Wallace well insists, that we shall hold to that degree of fixity of the continents in their position, notwithstanding the submergences and emergences they have experienced, to which I have already adverted. We can now more precisely indicate this than was possible when Lyell produced his "Principles," and can reproduce the conditions of our continents in even the more ancient periods of their history. Some examples may be taken from the history of the American Continent, which is more simple in its arrangements than the double continent of Europ-Asia. We may select the early Devonian or Erian period, in which the magnificent flora of that age—the earliest certainly known to us—made its appearance.

Imagine the whole interior plain of North America submerged, so that the continent is reduced to two strips on the east and west, connected by a belt of Laurentian land on the north. In the great Mediterranean sea thus produced, the tepid water of the equatorial current circulated, and it swarmed with corals, of which we know no less than one hundred and fifty species, and with other forms of life appropriate to warm seas. On the islands and coasts of this sea was introduced the Erian flora, appearing first in the north, and with that vital-

ity and colonizing power of which, as Hooker has well shown, the Scandinavian flora is the best modern type, spreading itself to the south. A very similar distribution of land and water in the Cretaceous age gave a warm and equable climate in those portions of North America not submerged, and coincided with the appearance of the multitude of broad-leaved trees of modern types introduced in the early and middle Cretaceous, and which prepared the way for the mammalian life of the Eocene.

We may take a still later instance from the second continental period of the later Pleistocene or early modern, when there would seem to have been a partial or entire closure of the North Atlantic against the Arctic ice, and wide extensions seaward of the European and American land, with possibly considerable tracts of land in the vicinity of the equator, while the Mediterranean and the Gulf of Mexico were deep inland lakes. The effect of such conditions on the climates of the northern hemisphere must have been prodigious, and their investigation is rendered all the more interesting because it would seem that this continental period of the post-glacial age was that in which man made his first acquaintance with the coasts of the Atlantic, and possibly made his way across its waters. We have in America ancient periods of cold, as well as of warmth.

I have elsewhere referred to the bowlder conglomerates of the Huronian, of the Cambrian and Ordovician, of the millstone-grit period of the Carboniferous and of the early Permian ; but would not venture to affirm that either of these periods was comparable in its cold with the later glacial age, still less with that imaginary age of continental glaciation assumed by certain of the more extreme theorists. These ancient conglomerates were probably produced by floating ice, and this at periods when in areas not very remote temperate floras and faunas could flourish.

The glacial periods of our old continent occurred in times when the surface of the submerged land was opened up to the northern currents, drifting over it mud and sand and stones, and rendering nugatory, in so far at least as the bottom of the sea was concerned, the effects of the superficial warm streams. Some of these beds are also peculiar to the eastern margin of the continent, and indicate ice-drifts along the Atlantic coast in the same manner as at present, while conditions of greater warmth existed in the interior. Even in the more recent glacial age, while the mountains were covered with snow, and the lowlands submerged under a sea laden with ice, there were interior tracts in somewhat high latitudes of America in which hardy forest-trees and herbaceous plants flourished abundantly ; and these were by no means exceptional "interglacial" periods. Thus we can show that, while from the remote Huronian period to the Tertiary the American land occupied the same position as at present, and while its changes were merely changes of relative level as compared with the sea, these

have so influenced the ocean-currents as to cause great vicissitudes of climate.

Without entering on any detailed discussion of that last and greatest glacial period which is best known to us, and is more immediately connected with the early history of man and the modern animals, it may be proper to make a few general statements bearing on the relative importance of sea-borne and land ice in producing those remarkable phenomena attributable to ice-action in this period. In considering this question it must be borne in mind that the greater masses of floating ice are produced at the seaward extremities of land glaciers, and that the heavy field-ice of the Arctic regions is not so much a result of the direct freezing of the surface of the sea as of the accumulation of snow precipitated on the frozen surface.

In reasoning on the extent of ice-action, and especially of glaciers in the Pleistocene age, it is necessary to keep this fully in view. Now, in the formation of glaciers at present—and it would seem also in any conceivable former state of the earth—it is necessary that extensive evaporation should conspire with great condensation of water in the solid form. Such conditions exist in mountainous regions sufficiently near to the sea, as in Greenland, Norway, the Alps, and the Himalayas; but they do not exist in low Arctic lands like Siberia or Grinnell-land, nor in inland mountains. It follows that land glaciation has narrow limits, and that we can not assume the possibility of great confluent or continental glaciers covering the interior of wide tracts of land. No imaginable increase of cold could render this possible, inasmuch as there could not be a sufficient influx of vapor to produce the necessary condensation; and the greater the cold, the less would be the evaporation. On the other hand, any increase of heat would be felt more rapidly in the thawing and evaporation of land ice and snow than on the surface of the sea.

Applying these very simple geographical truths to the North Atlantic continents, it is easy to perceive that no amount of refrigeration could produce a continental glacier, because there could not be sufficient evaporation and precipitation to afford the necessary snow in the interior. The case of Greenland is often referred to, but this is the case of a high mass of cold land with sea, mostly open, on both sides of it, giving, therefore, the conditions most favorable to precipitation of snow. If Greenland were less elevated, or if there were dry plains around it, the case would be quite different, as Nares has well shown by his observations on the summer verdure of Grinnell-land, which, in the immediate vicinity of North Greenland, presents very different conditions as to glaciation and climate. If the plains were submerged and the Arctic currents allowed free access to the interior of the Continent of America, it is conceivable that the mountainous regions remaining out of water would be covered with snow and ice, and there is the best evidence that this actually occurred in the glacial period;

but with the plains out of water this would be impossible. We see evidence of this at the present day in the fact that in unusually cold winters the great precipitation of snow takes place south of Canada, leaving the north comparatively bare, while as the temperature becomes milder the area of snow deposit moves farther to the north. Thus, a greater extension of the Atlantic, and especially of its cold, ice-laden Arctic currents, becomes the most potent cause of a glacial age.

I have long maintained these conclusions on general geographical grounds, as well as on the evidence afforded by the Pleistocene deposits of Canada; and, in an address the theme of which is the ocean, I may be excused for continuing to regard the supposed terminal moraines of great continental glaciers as nothing but the southern limit of the ice-drift of a period of submergence. In such a period the southern margin of an ice-laden sea where its floe-ice and bergs grounded, or where its ice was rapidly melted by warmer water, and where, consequently, its burden of bowlders and other *débris* was deposited, would necessarily present the aspect of a moraine, which, by the long continuance of such conditions, might assume gigantic dimensions. Let it be observed, however, that I fully admit the evidence of the great extension of local glaciers in the Pleistocene age, and especially in the times of partial submergence of the land.

I am old enough to remember the sensation caused by the delightful revelations of Edward Forbes respecting the zones of animal life in the sea, and the vast insight which they gave into the significance of the work on minute organisms previously done by Ehrenberg, Lonsdale, and Williamson, and into the meaning of fossil remains. A little later the soundings for the Atlantic cable revealed the chalky foraminiferal ooze of the abyssal ocean; still more recently the wealth of facts disclosed by the Challenger voyage, which naturalists have not yet had time to digest, have opened up for us new worlds of deep-sea life. The bed of the deep Atlantic is covered for the most part by a mud or ooze largely made up of the *débris* of foraminifera and other minute organisms mixed with fine clay. In the North Atlantic the Norwegian naturalists call this the Biloculina mud.

Farther south the Challenger naturalists speak of it as Globigerina ooze. In point of fact it contains different species of foraminiferal shells, Globigerina and Orbulina being in some localities dominant, and in others other species, and these changes are more apparent in the shallower portions of the ocean. It is also to be observed that there are means for disseminating coarse material over the ocean-bed. There are in the line of the Arctic current on the American coast great sand-banks, and off the coast of Norway, and constitute a considerable part of the bottom material. Soundings and dredgings off Great Britain, and also off the American coast, have shown that fragments of stone referable to Arctic lands are abundantly strewed over

the bottom along certain lines, and the Antarctic Continent, otherwise almost unknown, makes its presence felt to the dredge by the abundant masses of crystalline rock, drifted far from it to the north.

These are not altogether new discoveries. I had inferred many years ago, from stones taken up by the hooks of fishermen on the banks of Newfoundland, that rocky material from the north is dropped on these banks by the heavy ice which drifts over them every spring, that these stones are glaciated, and that after they fall to the bottom sand is drifted over them with sufficient velocity to polish the stones and to erode the shelly coverings of Arctic animals attached to them. If, then, the Atlantic basin were upheaved into land, we should see beds of sand, gravel, and bowlders with clay flats and layers of marl and limestone. According to the Challenger reports, in the Antarctic seas south of 64°, there is blue mud with fragments of rock in depths of twelve hundred to two thousand fathoms. The stones, some of them glaciated, were granite, diorite, amphibolite, mica-schist, gneiss, and quartzite. This deposit ceases and gives place to Globigerina ooze and red clay at 46° and 47° south; but even farther north there is sometimes as much as forty-nine per cent of crystalline sand. In the Labrador current a block of syenite weighing four hundred and ninety pounds was taken up from thirteen hundred and forty fathoms, and in the Arctic current, one hundred miles from land, was a stony deposit, some stones being glaciated. Among these were smoky quartz, quartzite, limestone, dolomite, mica-schist, and serpentine; also particles of monoclinic and triclinic feldspar, hornblende, augite, magnetite, mica, and glauconite—the latter, no doubt, formed in the sea-bottom, the others drifted from Eozoic and Palæozoic formations to the north.

A remarkable fact in this connection is that the great depths of the sea are as impassable to the majority of marine animals as the land itself. According to Murray, while twelve of the Challenger's dredgings taken in depths greater than two thousand fathoms gave ninety-two species, mostly new to science, a similar number of dredgings in shallower water near the land gave no less than one thousand species. Hence arises another apparent paradox relating to the distribution of organic beings. While at first sight it might seem that the chances of wide distribution are exceptionally great for marine species, this is not so. Except in the case of those which enjoy a period of free locomotion when young, or are floating and pelagic, the deep ocean sets bounds to their migrations. On the other hand, the spores of cryptogamic plants may be carried for vast distances by the wind, and the growth of volcanic islands may effect connections which, though only temporary, may afford opportunity for land animals and plants to pass over.

With reference to the transmission of living beings across the Atlantic, we have before us the remarkable fact that from the Cambrian

age onward there were on the two sides of the ocean many species of invertebrate animals, which were either identical, or so closely allied as to be possibly varietal forms. In like manner the early plants of the Upper Silurian, Devonian, and Carboniferous present many identical species; but this identity becomes less marked in the vegetation of the more modern times.

In so far as plants are concerned, it is to be observed that the early forests were largely composed of cryptogamous plants, and the spores of these in modern times have proved capable of transmission for great distances. In considering this, we can not fail to conclude that the union of simple cryptogamous fructification with arboreal stems of high complexity, so well illustrated by Dr. Williamson, had a direct relation to the necessity for rapid and wide distribution of these ancient trees. It seems also certain that some spores, as, for example, those of the Rhizocarps, a type of vegetation abundant in the Palæozoic, and certain kinds of seeds, as those named *Ætheotesta* and *Pachytheca*, were fitted for flotation. Further, the periods of Arctic warmth permitted the passage round the northern belt of many temperate species of plants, just as now happens with the Arctic flora; and when these were dispersed by colder periods they marched southward along both sides of the sea on the mountain-chains. The same remark applies to northern forms of marine invertebrates, which are much more widely distributed in longitude than those farther south. The late Mr. Gwyn Jeffreys, in one of his latest communications to this Association, stated that fifty-four per cent of the shallow-water mollusks of New England and Canada are also European, and of the deep-sea forms thirty out of thirty-five; these last, of course, enjoying greater facilities for migration than those which have to travel slowly along the shallows of the coasts in order to cross the ocean and settle themselves on both sides. Many of these animals, like the common muscle and sand-clam, are old settlers which came over in the Pleistocene period, or even earlier. Others, like the common periwinkle, seem to have been slowly extending themselves in modern times, perhaps even by the agency of man. The older immigrants may possibly have taken advantage of lines of coast now submerged, or of warm periods, when they could creep around by the Arctic shores.

Mr. Herbert Carpenter and other naturalists employed on the Challenger collections have made similar statements respecting other marine invertebrates, as, for instance, the Echinoderms, of which the deep-sea crinoids present many common species, and my own collections prove that many of the shallow-water forms are common. Dall and Whiteaves have shown that some mollusks and Echinoderms are common even to the Atlantic and Pacific coasts of North America; a remarkable fact, testifying at once to the fixity of these species, and to the manner in which they have been able to take advantage of geographical changes. Some of the species of whelks common to the

Gulf of St. Lawrence and the Pacific are animals which have no special locomotive powers even when young, but they are northern forms not proceeding far south, so that they may have passed through the Arctic seas.

In this connection it is well to remark that many species of animals have powers of locomotion in youth, which they lose when adult, and that others may have special means of transit. I once found at Gaspé a specimen of the Pacific species of *Coronula*, or whale-barnacle, the *C. reginæ* of Darwin, attached to a whale taken in the Gulf of St. Lawrence, and which had probably succeeded in making that passage round the north of America which so many navigators have essayed in vain. It is to be remarked here that while many plants and marine invertebrates are common to the two sides of the Atlantic, it is different with land-animals, and especially vertebrates.

I do not know that any fossil insects or land-snails or millipedes of Europe and America are specifically identical, and of the numerous species of batrachians of the Carboniferous and reptiles of the Mesozoic all seem to be distinct on the two sides. The same appears to be the case with the Tertiary mammals, until in the later stages of that great period we find such genera as the horse, the camel, and the elephant appearing on the two sides of the Atlantic; but even then the species seem different, except in the case of a few northern forms. Some of the longer-lived mollusks of the Atlantic furnish suggestions which remarkably illustrate the biological aspect of these questions. Our familiar friend the oyster is one of these. The first-known oysters appear in the Carboniferous in Belgium and in the United States of America. In the Carboniferous and Permian they are few and small, and they do not culminate till the Cretaceous, in which there are no less than ninety-one so-called species in America alone; but some of the largest known species are found in the Eocene. The oyster, though an inhabitant of shallow water, and very limitedly locomotive when young, has survived all the changes since the Carboniferous age, and has spread itself over the whole northern hemisphere. I have collected fossil oysters in the Cretaceous clays of the *coulées* of Western Canada, in the Lias shales of England, in the Eocene and Cretaceous beds of the Alps, of Egypt, of the Red Sea coast, of Judea, and the heights of Lebanon. Everywhere and in all formations they present forms which are so variable and yet so similar that one might suppose all the so-called species to be mere varieties. Did the oyster origiate separately on the two sides of the Atlantic, or did it cross over so promptly that its appearance seems to be identical on the two sides? Are all the oysters of a common ancestry, or did the causes, whatever they were, which introduced the oyster in the Carboniferous, act over again in later periods? Who can tell?

This is one of the cases where causation and development—the two scientific factors which constitute the bases of what is vaguely called

evolution—can not easily be isolated. I would recommend to those biologists who discuss these questions to addict themselves to the oyster. This familiar mollusk has successfully pursued its course and has overcome all its enemies, from the flat-toothed selachians of the Carboniferous to the oyster-dredgers of the present day, has varied almost indefinitely, and yet has continued to be an oyster, unless indeed it may at certain portions of its career have temporarily assumed the disguise of a Gryphæa or an Exogyra. The history of such an animal deserves to be traced with care, and much curious information respecting it will be found in the report which I have cited. But in these respects the oyster is merely an example of many forms. Similar considerations apply to all those Pliocene and Pleistocene mollusks which are found in the raised sea-bottoms of Norway and Scotland, on the top of Moel Tryfaen in Wales, and at similar great heights on the hills of America, many of which can be traced back to early Tertiary times, and can be found to have extended themselves over all the seas of the northern hemisphere. They apply in like manner to the ferns, the conifers, and the angiosperms, many of which we can now follow without even specific change to the Eocene and Cretaceous. They all show that the forms of living things are more stable than the lands and seas in which they live.

If we were to adopt some of the modern ideas of evolution, we might cut the Gordian knot by supposing that, as like causes can produce like effects, these types of life have originated more than once in geological time, and need not be genetically connected with each other. But while evolutionists repudiate such an application of their doctrine, however natural and rational, it would seem that Nature still more strongly repudiates it, and will not allow us to assume more than one origin for one species.

Thus the great question of geographical distribution remains in all its force, and, by still another of our geological paradoxes, mountains become ephemeral things in comparison with the delicate herbage which covers them, and seas are in their present extent but of yesterday when compared with the minute and feeble organisms that creep on their sands or swim in their waters. The question remains, Has the Atlantic achieved its destiny and finished its course, or are there other changes in store for it in the future? The earth's crust is now thicker and stronger than ever before, and its great ribs of crushed and folded rock are more firm and rigid than in any previous period. The stupendous volcanic phenomena manifested in Mesozoic and early Tertiary times along the borders of the Atlantic have apparently died out. These facts are in so far guarantees of permanence. On the other hand, it is known that movements of elevation along with local depression are in progress in the Arctic regions, and a great weight of new sediment is being deposited along the borders of the Atlantic, especially on its western side, and this is not improbably connected

with the earthquake-shocks and slight movements of depression which have occurred in North America. It is possible that these slow and secular movements may go on uninterruptedly until considerable changes are produced; but it is quite as likely that they may be retarded or reversed. It is possible, on the other hand, that after the long period of quiescence which has elapsed there may be a new settlement of the ocean-bed, accompanied with foldings of the crust, especially on the western side of the Atlantic, and possibly with renewed volcanic activity on its eastern margin. In either case a long time relatively to our limited human chronology may intervene before the occurrence of any marked change.

On the whole, the experience of the past would lead us to expect movements and eruptive discharges in the Pacific rather than in the Atlantic area. It is therefore not unlikely that the Atlantic may remain undisturbed, unless secondarily and indirectly, until after the Pacific area shall have attained to a greater degree of quiescence than at present. But this subject is one too much involved in uncertainty to warrant us in following it further. In the mean time the Atlantic is to us a practically permanent ocean, varying only in its tides, its currents, and its winds, which science has already reduced to definite laws, so that we can use if we can not regulate them. It is ours to take advantage of this precious time of quietude, and to extend the blessings of science and of our Christian civilization from shore to shore until there shall be no more sea, not in the sense of that final drying-up of Old Ocean to which some physicists look forward, but in the higher sense of its ceasing to be the emblem of unrest and disturbance and the cause of isolation.

I must now close this address with a short statement of the general objects which I have had in view in directing your attention to the geological development of the Atlantic. We can not, I think, consider the topics to which I have referred without perceiving that the history of ocean and continent is an example of progressive design, quite as much as that of living beings. Nor can we fail to see that, while in some important directions we have penetrated the great secret of Nature in reference to the general plan and structure of the earth and its waters and the changes through which they have passed, we have still very much to learn, and perhaps quite as much to unlearn, and that the future holds out to us and to our successors higher, grander, and clearer conceptions than those to which we have yet attained. The vastness and the might of Ocean, and the manner in which it cherishes the feeblest and most fragile beings, alike speak to us of Him who holds it in the hollow of his hand, and gave to it of old its boundaries and its laws; but its teaching ascends to a higher tone when we consider its origin and history, and the manner in which it has been made to build up continents and mountain-chains, and at the same time to nourish and sustain the teeming life of sea and land.

# THE NEW REQUISITIONS FOR ADMISSION AT HARVARD COLLEGE.*

By Professor JOSIAH PARSONS COOKE.

AT the close of the last academical year the Faculty of Harvard College published a new scheme of requisition for admission, which will be followed at the admission examination of 1887, and thereafter. This scheme has been very slowly matured. It was originally prepared by a large committee of the college faculty, and was discussed in all its details for more than three years, first by the faculty, afterward by the corporation and the Board of Overseers, and finally was adopted by all the governing boards of the college. The scheme is complex, and any one desiring to understand all its possibilities must study the details in the pamphlet in which it has been announced. It is sufficient for the present purpose to say that, while it permits and even encourages the old line of linguistic studies on which students have hitherto been prepared for all the New England colleges nominally with nearly the same requisitions, the new plan opens other avenues of admission; and, among these, one to which we desire especially to call attention, as it demands and invites a thorough preparation in mathematics and physical science, with only that minimum of linguistic training which is universally regarded as an essential prerequisite of liberal culture.

In the new scheme students will be admitted to Harvard College as candidates for the B. A. degree who can write correctly a short English composition, and thus show that they are acquainted with a few prescribed classical English works; who can read at sight simple Latin, German, and French prose; who have a general knowledge of the history of the United States and of England; who have mastered the elementary mathematics, including analytic geometry and the rudiments of mechanics; and, lastly, who have had a certain amount of laboratory practice in physical science, including both physics and chemistry.

Of the several alternatives which the new scheme offers, the one above described will probably be chosen by most students who are seeking a scientific rather than a literary education. But this general plan of preparatory studies may be varied in details to meet different circumstances: thus, an advanced course in Latin or French may be offered in place of the German; but this substitution is not generally advisable, for the study of German, if deferred, must be taken up in college (the ability to read ordinary German as well as French prose

* Descriptive List of Experiments on the Fundamental Principles of Chemistry. By Josiah Parsons Cooke. (For the use of Teachers preparing Students for the Admission Examination in Chemistry at Harvard College.)

being an essential requisite for the A. B. degree), and this linguistic power is more easily acquired in early youth than afterward, when the mind is engrossed with severer studies.

This broadening of the requisites for admission is the last step in a series of changes by which, at Harvard College, scientific culture has been placed on the same footing as literary culture, and recognized as an equally fitting preparation for the degrees in arts. Those who have advocated these changes have seen clearly from the first that the study of natural science could not compete with the study of literature as a means of culture unless the discipline were equally severe, and unless legitimate scientific methods were strictly followed. To master a scientific subject as a body of systematized truth, and present it elegantly at a written examination, is a literary work, and the ability to do this work well is a normal result of literary training. The nature of the subject-matter does not essentially alter the character of the mental effort, and the power of ready acquisition and clear expression works very much in the same way, whether the material fashioned be science, history, or literature. This literary power is a talent of the very highest order, in many professions the one power needed, and in all professions a power of great value. But it is not the scientific power. It is not the power by which the physician investigates disease, by which the navigator crosses the ocean, or the geologist explores a continent; it is not the power by which a large part of the practical work of modern civilization is accomplished. The true test of scientific power is the ability to interpret Nature, and this can only be acquired by cultivating to the utmost—1. The perceptive faculty, by which observations are made; 2. The delicate manipulation required in experimenting; and, 3. The inductive method of reasoning by which correct conclusions are drawn from the results of observation or experiment. Moreover, long experience has shown that the old literary methods of education, so far from tending to cultivate the scientific faculties, rather tend to blunt them, and therefore that, without unusual native talent, the best results of scientific training can not be attained unless we begin with pupils at an early age. It is easy to awaken among college students a taste for natural science, and all the easier on account of the barrenness of their previous studies; but, so long as the average college student is not taught to use his perceptive faculties until that late stage of his education, it is obvious that the standard of scientific culture in our higher institutions of learning can not compare with that of the literary culture which has engrossed the attention of the student from childhood. We can not reach a standard that will command general respect until we can secure real science training in the preparatory schools. The acquisition of scientific knowledge by the study of text-books, however excellent in themselves, will not in the least degree promote this end, unless possibly by awakening a desire to study Nature. What we require is, that the eye should

be trained to observe, the hand to experiment, and the judgment to reason. Hence it is that, in the new scheme of requisitions for admission to Harvard College, the requisition in chemistry has been stated thus: "A course of at least sixty experiments in 'general chemistry,' actually performed at school by the pupil. . . . The candidate will be required to pass both a written and a laboratory examination. The written examination will be directed to testing the candidate's knowledge of experiments and experimenting, as well as his knowledge of the principles and results of the respective sciences. The laboratory examination will be directed to testing his skill in experimenting. At the hour of the written examination the candidate will be required to hand in the original note-book in which he recorded the steps and results of the experiments which he performed at school, and this note-book must bear the indorsement of his teacher, certifying that the notes are a true record of the pupil's work." The requisition in physics is stated in similar language.

The pamphlet, whose title is given at the head of this notice, was prepared chiefly for the purpose of accurately defining the requisition above stated. It presents certain novel features.

In the first place, the course here presented is limited to the fundamental principles of chemistry, and no attempt is made to develop the scheme of the chemical elements. At Cambridge this scheme is fully illustrated in a subsequent course, which is the natural sequel of the one we are here discussing. Such a limitation of the subject-matter has a very great advantage in an elementary course, by enabling the teacher to fix attention on the general principles of the science, selecting for illustrations only those facts which have a general interest, and avoiding the great mass of details which usually so greatly encumber the elementary presentation of chemistry. But, although the scope of the course is thus limited, all the fundamental principles of the science are considered, the most important of its facts are illustrated, and the general method of each of its great departments is explained.

In the second place, demonstrations by the teacher are systematically used in this pamphlet to supplement the experiments made by the students, and a complete outline is given of a systematic course of instruction in the elements of chemical science which is logically followed out from beginning to end. The ground is taken that it is not necessary, in order to secure the full advantages of the experimental method, that each student should perform every experiment for himself. If this is attempted, a course in chemistry must be made very meager, since, on account of either their danger or their expense, a large number of the most instructive experiments must be omitted; but these can be shown once for all, without danger and with comparatively slight cost, on the lecture-table. If the student has actually performed in the laboratory a sufficient number of experi-

ments to give him the spirit of the method, he will usually comprehend the full significance of others which are plainly exhibited before him.

In the third place, quantitative as well as qualitative experiments are introduced from the first, and all the usual measurements of chemistry are illustrated. Examples are given of the determination of melting and boiling points, the student first constructing the thermometer with which the determinations are made. He further learns how to measure with the calorimeter the amount of heat evolved in chemical processes, and to find the specific heat of the materials used. There are also simple examples of quantitative analysis and of the determination of molecular and atomic weights; and, lastly, easy methods of determining gas and vapor densities place even those measurements within the reach of elementary students.

In the fourth place, great pains have been taken to reduce the expense of the course to the lowest possible point. To this end common household utensils such as may be made by a tinsmith, or found at any house-furnishing store, have been adapted to the purposes of instruction. The small (so-called "American") petroleum cooking-stove serves an admirable purpose for heating, its oven is an excellent drying-chamber or hot-air bath, and, with a simple attachment furnished by the makers, it may be used as a tube-furnace. So also a farina-kettle makes a good steam-bath; and the quick-sealing fruit or milk jars are not only good gas-holders, but enable any student to perform experiments which formerly were only made with costly apparatus. The only apparatus of precision required are the scales and thermometers, which can be purchased from the dealers in chemical supplies at a very moderate cost. Indeed, the expense of the absolutely necessary outfit for a class of twenty students need not exceed one hundred dollars, and twice this sum will purchase everything that could possibly be needed for the course here laid out.

Lastly, the course has been made inductive throughout. It is a wise economy in education to seek from each study that discipline which it best affords. The memory is a greatly abused faculty. The necessities of language, the commonplaces of history, and the requirements of literature and art, task even the most retentive memory, and it is a waste of resources to overburden it with a mass of scientific details which, even if retained, will be of little value except to the specialist. Chemistry is peculiarly an inductive science, and to teach it deductively is to use it for a discipline, which is much better furnished by mathematics or mechanics; yet chemistry is taught deductively whenever, as in most elementary text-books, the chief stress is laid upon the symbolical expression of chemical facts and principles. To secure the peculiar discipline of chemistry, it is essential that it should be studied as it has been built up. The student must begin by observing phenomena, and be led up to the general principles through his own inferences. To begin with an abstract statement of

these principles, or, what amounts to the same thing, to express from the first every phenomenon observed in symbolical language which embodies these principles, is to invert the natural order, and to abandon the inductive method. Undoubtedly, such are the precision and grasp of this system of symbols that it is of the greatest value in aiding the chemist to see relations and predict results which, without its aid, he might not have discovered at all. Nevertheless, it must be remembered that chemical symbols simply stand for the facts and theories they were devised to express, and for nothing more. They have not the generality of mathematical formulæ, and are, therefore, far inferior to such formulæ as forms of deductive reasoning. In the pamphlet before us the full meaning of chemical symbols is explained, but they are not used until the principles of the science have been developed.

An inspection of this pamphlet will show that the author, who has been for thirty years one of the most constant advocates of scientific culture in school and college, has no desire to lower the standard of university education. Except to those who have unusual mathematical and scientific talents the new scheme of preliminary studies is a decidedly more difficult way of entering college than the old classical curriculum. It has, however, a special end in view, and has been adapted to this purpose with great care, and is the result of large experience. Our colleges have always been the nurseries of scholars, of men who knew how "to clothe thought in beautiful and suggestive language, to weave argument into correct and persuasive forms, and to kindle enthusiasm by eloquence."* But we earnestly hope that while rendering as fully as ever this high service to the state by educating the men who will defend the right and repress the wrong, uphold the true and expose the false, these same schools of liberal culture will also do the equally important work of preparing earnest men "to unravel the mysteries of the universe, to probe the secrets of disease, to direct the forces of Nature, and to develop the resources of this earth."*

## LIFE IN THE SOUTH-SEA ISLANDS.†

By Captain CYPRIAN BRIDGE, R. N.

THE inhabitants of the New Hebrides are Melanesians, divided into a multitude of independent and usually hostile tribes. On several islands there are communities of Polynesians, some of whom—as shown by their complexions—have preserved, among their Mela-

* The writer, in an address to the Harvard Club of Rhode Island, Newport, August 25, 1883, and published in this "Monthly" for November of the same year.

† Abridged from a paper on "Cruises in Melanesia," etc., read before the Royal Geographical Society, April 12, 1883.

nesian neighbors, their purity of descent. One of the difficulties of communicating with the natives is due to the immense variety of languages, which renders it impossible to obtain the services of an interpreter likely to be of use in more than a single district. This difficulty has seriously impeded the work of the missionaries of the Presbyterian Church who labor in the islands from Ambrym southward, and of the Anglican Melanesian Mission, who have taken spiritual charge of the northern islands, the Banks group, and the Solomons. The necessity of confronting this difficulty has been advantageous to linguistic science, for the Rev. Dr. Codrington, of the Anglican Mission, has recently published a learned work on "The Languages of Melanesia." As a rule, white men and natives communicate with each other by means of a very singular jargon, like the "pigeon English" of China, known as "sandal-wood English," or the "*bêche de mer* lingo," designations which explain its origin. Bearing in mind who the devisers of this dialect were, it is not surprising that a prominent characteristic should be the frequent interpolation into a sentence of exceptionally vigorous profanity. This the native linguist utters without a suspicion of its being improper. A few phrases, without the ingredient just mentioned, will convey an idea of what the jargon is. "That fellow man he no good" = "That is a bad man." "That fellow woman Mary belong a me" = "That woman is my wife." "Big fellow yam he stop Tanna" = "Large yams grow in Tanna." This "pigeon" is the universal mode of communication between white men, except missionaries, and islanders throughout the southwestern Pacific, and is used by both Englishmen and foreigners. I have even heard the oath administered to Melanesian witnesses in a French court of justice at Noumea in the following terms: "Me talkee true, me no tell lie, me no gammon; me," raising the right hand to the sky, "swear." At many places even this imperfect method of conversing is unknown; but so intelligent and such adepts in gesture-language are the natives that they understand and make themselves understood by a stranger much more thoroughly than the inexperienced would expect.

At the time of my visit there were, including the wives and children of the missionaries, between eighty and a hundred white residents in the group. There are probably now fully a hundred in all. Aneiteum is completely Christian, and the natives are among the most devout of believers. A more attentive congregation than that attending the church at Port Inyang it would be impossible to meet with. The members carry with them to worship small libraries of devotional works, which require bags and baskets for their conveyance. On other islands progress has been made—progress with which the missionaries themselves are dissatisfied, but which appears very surprising to a stranger, who can discern the difficulties of the situation. As a rule, a missionary establishment consists of the clergyman and his wife, and

perhaps children, and one or two teachers, or subordinate lay missionaries, who are generally natives of other and remote islands. A plain wooden house is brought from New Zealand and put up for the missionary and his family, usually with his own hands and those of his brethren, who assemble for the purpose. A church, built in the style of the native houses—of reeds and mats—occasionally at the older stations of coral masonry, and a similar edifice for a school, with the comfortable huts of the teachers and the catechumens, complete the buildings of the station.

The other white men in the group follow the occupations of planters and traders. Attempts, in one case on a large scale, were made some years ago to grow cotton, but without much success, on the Island of Sandwich or Vaté. The cultivation of maize and coffee has been tried with better results on the same island. The staple vegetable product is *copra*, the dried pulp of the cocoanut.

The trader is usually the agent of a mercantile firm, which supplies him with a certain quantity of "trade" goods, and receives in return his copra. He has, as a rule, three or four laborers in his employment. Owing to a singular custom or prejudice, these are rarely natives of the island in which they work. He buys the nuts from his neighbors, and, with the assistance of his laborers, prepares the copra. On the more savage islands, arms and ammunition, as long as their introduction was allowed (and it is doubtful if it has yet been quite stopped), matches, pipes, and tobacco are the things commonly given for nuts. The price varies greatly, according to locality and year; but a pipe, a small fragment of tobacco, or a box of matches is frequently given for a dozen nuts. Every few months a small vessel visits the different stations, bringing goods and supplies of food for the traders and taking away the copra, which, on arrival in Europe, is converted into oil, the refuse being used in the manufacture of cake for cattle.

The New Hebrides natives differ greatly in physical qualities. On Mallicolo there are two distinct races, distinguished by the length and breadth of their skulls. Persons familiar with the group can readily point out an Espiritu-Santo man, a Sandwich man, a Pentecost man, or a Tanna man. The dress differs in nearly every island, and in some is very remarkable, more so on Tanna, on Erromango, on Api, and on Ambrym than would bear public description. The modes of dressing the hair are various. On Tanna it is dyed auburn or nearly gold color with lime, and is gathered into small thin locks which are wound round with a slender filament like thread. On Sandwich the women shave the skull completely. On Espiritu-Santo they shave it, but leave a broad ridge of frizzled hair in the middle from poll to forehead, like the well-known garniture of the head of a clown. I had the good fortune to witness some Santo ladies making their toilet, which was effected by mutual assistance. The person being dressed

had her head shaved with a knife of bamboo, of course without soap or any facilitating lather.

In the New Hebrides the villages are always invisible from the water. Each village as a rule consists of a set of different hamlets or collections of huts. The houses in the various islands differ greatly in architecture, but I always found them beautifully neat and clean. The dead are usually buried at the door of the hut. On Ambrym and some other islands the young unmarried men in a village always sleep in a large house specially set apart for them.

In general it may be said that all the Melanesians who have not been converted to Christianity are cannibals. It is not, however, to be supposed that human flesh is their ordinary diet. It is probable that none partake of it often, and that large numbers have only rare opportunities of doing so. They are almost invariably ashamed of cannibalism, and will generally conceal their indulgence in it or discontinue it if a white man comes to live among them.

Wars are nearly perpetual, and the non-Christian natives invariably go armed. I have been among natives whose custom it was not to lay aside their weapons even to eat, but keeping them in their right hand to take their food in the left. The spear, the bow and arrow, the club, and the tomahawk are all in use in the New Hebrides, but there are many fire-arms in the hands of the natives. The Tanna men have a high reputation for boldness, and even in ordinary intercourse they have a more independent bearing than most of their neighbors. Native wars are not usually very sanguinary; at least, pitched battles are few. The savage art of war consists in murdering stragglers and making forays to kill women and children, burn down villages, and lay waste plantations.

Nothing struck me more than the great intelligence of the natives of Oceania in general and of the Melanesians in particular. Within the limited sphere of their acquirements whatever they do they do thoroughly.

The Melanesians of the Solomon Islands are less known than their neighbors of the New Hebrides. The climate of the group is less favorable to white men.

The Solomon-Islanders are in general an aquatic people. Their canoes, except as New Ireland and New Britain are approached, have no outriggers. They are of graceful shape, of large size, built up of pieces, and with seams "payed" with a sort of vegetable pitch. The villages are usually near the water's edge and unconcealed by trees. The use of fire-arms is still not very common. But on some islands, notably Guadalcanar, they are expert bowmen. The Savo men make clubs covered with straw plaiting of singularly fine texture and tasteful pattern. Some of the spears are of prodigious length, and are tipped at the end with a human bone cut into a multitude of sharp and brittle points, which break off in a wound and are said to cer-

tainly cause death. Having succeeded with some difficulty in purchasing one of these at Tesemboko, a friendly native cautioned me against allowing any one to touch a point even with the finger, saying that, if any person did, "My word! he die quick."

New Britain is one of the most beautiful countries in the world. The contours of the lofty mountains are very graceful, and the variety of tints of the rich tropical verdure is as attractive as it is unusual. The dense foliage is interspersed with patches of grass of an emerald hue. At Matupi in Blanche Bay there is an active volcano, a curious volcanic island, and a region of hot springs. I traveled by land once from Nodup to Blanche Bay, and the heat and fatigue were more than compensated by the beauty and varied character of the scenery traversed. The New Britain people go entirely naked. They are not a fine race, and want the activity and vigor of the Solomon-Islanders. Foreigners have introduced a good many fire-arms among the inhabitants of Blanche Bay and Kambeirah, but as a rule the spear, usually adorned with brightly colored feathers, is their weapon. They build good houses and make excellent nets and ingenious fishing-baskets. They are the only cannibals I know who are not ashamed of their fondness for human flesh. A German settler told me that overtures were made to him to arrange the purchase of the body of a man who had been accidentally killed by a neighboring tribe with whom the would-be buyers were not friendly. The reason given was a desire to eat what otherwise might be wasted in a commonplace interment.

The curious and little understood ceremonies of the *duk-duk* are extensively performed in New Britain and the neighboring Duke of York group. One thing about them is certain, and that is, that those who are initiated into the mysteries obtain considerable influence over the rest of their tribesmen. There is another very remarkable custom, about which I was given information by the Rev. Mr. Rooney of the Wesleyan Mission, which labors in this part of Melanesia. It may be described as follows: If A injures B, B burns down C's hut, or makes a hole in his canoe, or sticks a spear in the pathway so that C is nearly sure to run against it. B lets C know that he has injured him, and the reason of it; when C is expected to settle the account with A, the first aggressor. On the whole, the New Britain people are the least attractive of all Melanesians whom I know. They are very dirty, and do not possess the skill in fashioning pottery, or carving wooden bowls, of their neighbors in the Solomons and the Admiralty Islands. Yet among them I had some very worthy friends. One of them I specially remarked from having been struck with the persistence with which he insisted on the observance of the curious Melanesian etiquette, that a person should never be asked his name. The savage has no objection to his name being known, but politeness requires that it should be asked of some one else. The New Britons have a curious money called *dawarra*, made of small shells perforated and strung on fibers of some

plant. It is counted by measure of length, and has some of the properties of the money of civilization, as it owes its value to the rarity of its material, and it can be easily divided into small sums.

The Ellice, the Gilbert (or, as they are usually called by the seamen, the Kingsmill), and the Marshall groups, are all composed of low, flat islands formed of coral. Some of them are nearly perfect *atolls*, Maraki in the northern Gilberts being perhaps the most perfect in the world.

It seems absurd to speak of the fertility of soil apparently composed almost entirely of sand, nevertheless even among these coral archipelagoes there are differences. The Marshall Islands have the most profuse natural growth of ferns and grasses; on the Gilbert Islands there is not even a fern; while the Ellice Islands hold an intermediate place between the sterility of the latter and the comparative fertility of the former. It is customary to reproach the natives of Oceania with invincible indolence; and, if it be a fault, I fear they must be convicted of desultoriness and unsteadiness in their work. The amount done in a year would if spread over the whole period give, I believe, a very respectable daily average. The labor expended by the Ellice-Islanders in cultivating their lands and growing the huge *taro*, which is the staple of their diet, must have been enormous. The vegetable is planted in vast trenches which look as though they had belonged to some great fortress long ago fallen into ruin. Even with the best implements the excavations would be extremely laborious, but one is lost in astonishment when one finds that many of the taro-beds now in existence were excavated by generations in possession only of tools of shell or wood.

All the islanders are expert fishermen. Shark's fin being an article of export, the shark is eagerly sought for. He is often caught without a hook; a piece of bait is put on the end of a line passed through a noose in a larger line and towed from a canoe. As the shark is seen to follow the bait, it is gradually hauled up till his head and shoulders are past the noose. The latter is then quickly tightened. Another plan, of which I was told on good authority, is even more remarkable. The sharks are supposed to sleep in rather shoal water under projecting pieces of coral with their heads just protruding. When a Gilbert-Islander sees one in this position he dives down with a small stick in his hand and gives the fish a tap on the nose, repeating it until the shark, for comfort's sake, changes his position and leaves his tail where his head had been. This is the fisherman's chance, and a second dive with a noose at the end of a line soon makes him master of his game. I am bound to say that I never saw this mode of fishing.

The Ellice-Islanders are all Christians, having been converted by the missionaries of the London Mission Society. They are inoffensive folk and have no arms. The Nukulailai people declare that they never did have any; but the natives of other islands undoubtedly had some

until comparatively recently. They are well educated, can all read, and are most persistent letter-writers. No present is more acceptable to them than a few sheets of paper and some pens.

Some of the islands of the group were nearly depopulated twenty years ago by Peruvian kidnappers, who carried off many natives to work in Peru. As a general rule the population of each island is very small—never, as far as I am aware, exceeding a few hundreds. All are governed by a constitutional sovereign and a *kaupuli*, or parliament. The form of government, in its present state, is to a great extent the work of the missionaries. At Vaitupu I noticed in the *kaupuli* house some curious couches, carved out of single pieces of wood, with four legs and a solid block like a pillow at one end. To my inquiries it was replied that as some members of the assembly are fond of long speeches, the debates are occasionally protracted, and wearied legislators get rather sleepy, so the couches are provided to enable them to slumber in comfort. All the natives wear European clothes of some sort. The men usually put on at least a shirt; the women's dress is peculiar. They wear a long garment of colored calico, tight round the neck, and reaching in ungirt looseness to the heels. On their heads they put a curious high-crowned hat, cross-laced with bright ribbons, exactly resembling the head-gear of a brigand in the opera of "Fra Diavolo." Ladies of a certain age in the Archipelago are inclined to *embonpoint;* and a crowd of portly dames streaming out of church in their flowing calicoes and brigand hats, always many sizes too small for them, is a sight not soon to be forgotten.

The Gilbert-Islanders are only partially Christianized. The southern portion of the group is under the London Mission; some of the other islands are under American missionaries, who, however, do not reside in them. Like the Ellice Islands, these also were once governed by kings; but in all the southern part regal government has been abolished, and a sort of federal republic has been established in several islands. The natives seem to have an innate capacity for parliamentary institutions. I have been present at several debates among them, some of which were so far of importance that on their issue depended whether we should be at peace or at war with the inhabitants. Nothing could exceed the regularity and decorum of the proceedings, and some of the speakers were assuredly fluent, and apparently eloquent. The islanders are capital sailors, fearlessly visiting distant islands in canoes of large size, not dug out of single trees but built up of pieces. One very remarkable feature of the islands is their dense population. This is especially striking, as the islands are extremely barren.

The weapons of the Gilbert-Islanders are curious wooden swords and halberts, studded with shark's teeth. They make also complete suits of armor out of cocoanut-fiber, stiff hauberks, cuisses of matting, and close-fitting helmets, like those of the Crusaders. Fire-arms have

of late to a great extent replaced the old weapons, and the armor has been generally laid aside. It is odd that the custom of the duel should be common among the Gilbert natives. Duels are rarely to the death, but a wooden sword bristling with shark's teeth can, to judge from the tremendous scars on many of the men's bodies, inflict very severe wounds.

The Marshall Islands are less known than the Ellice or Gilbert groups. The Archipelago is divided into two chains; the Ralick, or western, and the Radack, or eastern. The Marshall Island men are tall, the women singularly short. Some of the latter sex, who are of high birth, are very good-looking, and extremely graceful. The men are tattooed on the body and right up to the temples. Those of chiefly family cover the whole body; commoners leave an unmarked patch from the armpit nearly to the waist. The lobe of the ear is perforated, and often greatly distended with an unclosed hoop of wood. When this ornament is not carried, the vacant loop of flesh is hung over the point of the ear. The women tattoo the back of the hand and the forearm nearly to the elbow in tasteful patterns, so that they appear to have on open-worked silk mitts. The male costume is decidedly picturesque. It consists of two enormous tassels of shreds of *vau* bark joined by a plaited strap and disposed round the body so as to form a kilt. It is kept in place by a cord covered with plaiting of pretty pattern, which cord, being often over a hundred feet long, is wound round the waist till it forms a large coil. Chiefs particularly affect great length of cord, which does not improve the wearer's appearance, as it makes the kilt too bunchy. With a coil of moderate size the kilt is very becoming, and recalls the Albanian *fustanella*. The women's dress is composed of two mats worked with devices of great taste. The so-called "Greek key" is common as an ornament at the edges. These mats are bound round with a cord, similar to that of the men, above the hips, leaving a few inches of mat above, while the rest reaches nearly to the ankle. The costume is thus very like a low-necked European gown without sleeves, and, though a little stiff for sitting down in, has an attractive appearance when the wearer stands.

The Marshall Island canoes are like those of the Gilbert Islands; but they are larger, and on the sloping platforms built out on each side there are frequently little houses in which three or four of the crew can sleep. The natives are great navigators. They actually make curious charts of thin strips of wood tied together with fibers. Some of these charts indicate the position of the different islands with a surprising approach to accuracy. Others give the directions of the prevailing winds and currents. These are used as instruments to determine the course to be steered, so as to take advantage of the wind and to allow for current-drift rather than as charts are used by us.

The low atolls of the three groups just spoken of are called by sail-

ors the "Line Islands," from their position with respect to the equator. In spite of their general unproductiveness, the number of cocoanut-trees is so large that there is a considerable export of copra. One English and three German firms have nearly the whole business in their hands. There is one American firm also, but its transactions must be much less extensive than those of the English, and of at least two of the German houses. All are represented by resident traders. At Majuro Messrs. Henderson and MacFarlane have a very complete and extensive head-station. At Jaluit the German firms of Hernsheim and Company, and the South Sea Company, the latter at the time of my visit under the style of Capelle and Company, have large head-stations for this part of Oceania.

The contrast between Kusaie and Ponapi in the Carolines and the low atolls of the Marshall, Gilbert, and Ellice groups, is striking and agreeable. Both of the former are called by our sailors "high islands," a designation which is soon appreciated by any one who has cruised among the groups mentioned. Kusaie is densely wooded and picturesque. Its soil is very fertile. The people, who only amount to between three and four hundred, are all Christians, having been converted by the American missionaries, who have an important station on the island. The American missionaries are fond of giving to the petty chiefs of the tribes with whom they come in contact the absurd title of king. Tokusa, the chief of Kusaie, which name includes all the islets near as well as the main island of Ualan, is accordingly called king, though his subjects are so few. He speaks English well, and is very intelligent and well-mannered. The natives are straight-haired and rather light-colored. They paint their canoes a dull red, with a pigment made of an ochreous earth found in two caves on Ualan. Their houses are large, with high-pitched roofs and elevated gables. Most of them now wear some article of European dress, but the garb of the country is a broad sash woven of the fiber of an inedible banana, frequently dyed black except at the ends, where there are some bright colored bars, which make it resemble the silk scarfs of the Roman peasantry.

On the little Island of Lelé, on which the natives live, there are some interesting ruins, which appear to be those of a fortress with Cyclopean walls of large irregular blocks of basalt, twenty-five to thirty feet thick. There are also canals and artificial harbors. The natives can give no account of them, though King Tokusa told me that he believed they had been constructed by his ancestors. In the splendid Island of Ponapi, the inhabitants of which are more barbarous than those of Kusaie, there are even more remarkable ruins. Four-sided platforms stand out of the water, and are composed of layers of hexagonal basaltic prisms, like those of the Giant's Causeway, transversely superimposed one on another, the prisms of a layer being at right angles to those of the one above or below it. These platforms

are arranged to form canal streets, and the walls of edifices erected on them are built of basaltic columns in like manner. The ruins are much overgrown with the rich vegetation of the tropics, but enough is visible to disclose the remains of a city, of a second Venice, of whose builders we are ignorant.

Yap, in the Western Carolines, is singularly interesting. The natives are good-looking and profusely tattooed. The hands and forearms of the women are tattooed with mitts as in the Marshall Islands. The houses are large and built of mats. They stand on an extensive platform of earth revetted with stones, against which is placed the curious stone money of the islanders. This is in the form of huge disks of arragonite, quarried in the Pelew Islands, more than two hundred miles away. The disks are like great grindstones, and frequently weigh three tons. People have said on hearing of this money that there was not much risk of its being stolen. Nevertheless, an American trader at Yap complained to me that some which had been placed in his charge had been carried off in the night.

I visited two other islands which may be included in the Caroline group. These were Nuguor and Greenwich Island, both low atolls. At Nuguor human sacrifices are still offered; one had occurred about two years before I was there. The inhabitants are of almost gigantic size. They are ruled by two queens, and have retained the tradition of their migration from Samoa and the name of the chief, Vavé, who led it. Greenwich Island is very little known. The Pelew-Islanders are a particularly interesting people. In each village there are large "club-houses," to which the younger men resort. A few women from neighboring villages also frequent them. It is not considered *comme il faut* for a woman to enter one in her own village. If she did she would become an outcast; going into one a mile or two off, however, in no way affects her position. The buildings are of wood, and the gable-ends are adorned with carvings and frescoes. There is also in the Pelew Islands a curious kind of money. It is really bits of antique glass vessels and jasper beads, which the people believe came down from the gods, but which in fact came out of the ships of early navigators.

In the Polynesian archipelagoes of Samoa and Tonga we find a superior race and, especially in the latter, a comparatively advanced civilization. The people of the two are akin. The Samoans are of a softer type than the Tongans, who live in a cooler climate. The beauty of the Samoan women has often been remarked, and it would be difficult to exaggerate it. The Tongans are of greater stature, and the women are rather handsome than pretty. The scenery of the Samoan Islands is only surpassed by that of New Britain and Eastern New Guinea. Except in the Vavau group, the Tongan scenery is at best rather poor, as the islands are, in general, low. Samoa is always hot, while the winter climate of Tonga-tàbu is delicious. Both archipela-

goes are visited by hurricanes, but they are apparently less violent than those of the West Indies and come rarely.

Tonga is trying a constitutional experiment on its own account. Mr. Baker, an ex-Wesleyan missionary, has drawn up a constitution to which the venerable King George, who was over ninety years old at the time of my visit, but was as vigorous as most men of sixty, has given his approval. There is a cabinet of which the ex-missionary is the head, a parliament, and a constitutional sovereign. There is also a regular judicial establishment. Great Britain has entered into treaty relations with Tonga, and has even accorded a limited jurisdiction over British subjects to Tongan courts. Englishmen in the South Seas are fond of laughing at the Tongan polity. But it is to the credit of the new state that its public expenditure is small, that it has been for years perfectly orderly, and that there are in the group probably five times as many miles of carriage-road as there are in our colony of Feejee. There are many Tongans still living who saw the first horse brought to their own particular island, and thought that it was a large kind of pig. There are hundreds of horses in the archipelago now, and most Tongans are fearless horsemen. They are also capital cricketers, which they owe to the good sense of that very able man, the Rev. Mr. Moulton, who is, or was till lately, at the head of the Wesleyan Mission. Mr. Moulton has founded an admirable college. The scholars receive an education equal to that given in the colonies. I was present at one of the public examinations, and among other surprises heard the first canto of the "Paradise Lost" recited in the native tongue. Most of the Tongans are Wesleyans, but there is also a Roman Catholic mission in the country, and a moderate number of the natives belong to that church.

All Pacific-Islanders, even many of the Melanesian cannibals, are distinguished by a remarkable refinement of external manners. The Polynesians excel all others; and, probably, no people in the world surpass the Tongans and Samoans in grace and dignity of deportment. The latter races are highly ceremonious, and great observers of etiquette. In Tonga at a *kava* party, where an infusion of the root of the *Piper methysticum* is drunk, the order of precedence is as strictly observed as it would be at a European state banquet. In Samoa the *kava* root is chewed by young ladies before being placed in the bowl. In Tonga it is invariably pounded on a lap-stone. Connoisseurs assert that the beverage is never so good as when the root has been chewed. I never quite got over my repugnance to that method of preparing it, and only drank of it sparingly and to avoid giving offense when out of Tonga. Even in Tonga I felt little inclination to indulge in it freely, possibly because I retain my youthful dislike to rhubarb and magnesia, the flavor of which that of *kava* closely resembles.

To one who has cruised much among the small islands of the Pacific, and who has grown familiar with the monotonous landscapes of

Australia, the scenery of New Guinea appears especially grand and imposing. It differs greatly in character.

The natives of the coast evidently belong to two distinct races. From a point rather to the westward of Port Moresby right on to Aroma, the people are light-colored, of tall and graceful figure, grave in manner, taciturn, and abhorring cannibalism. The men's dress is simply a strip of bark twisted into a string. The wearers of this express great contempt for neighboring tribes who go perfectly naked. The other race is black, of shorter and sturdier figure, nimble, cheerful, loquacious, and cannibal. The men wear a curious and decent costume of leaf. The women of both races wear the *titi* petticoat of grass, which is very like a ballet-dancer's skirt. At Port Moresby the houses are built half in the water. At Tupu-selei, Kailè, and Kappa-kappa, they stand out in the sea at a distance of a couple of hundred yards from the beach. Throughout the parts of New Guinea with which I am acquainted, the inhabitants are ingenious and industrious agriculturists, and carefully fence in their plantations. Their houses are large and well built. They make very fine fishing-nets. The canoes of Port Moresby are of enormous size, and the trees out of which they are dug are procured by barter from tribes living a long way off. The Port Moresby pottery is made in large quantities for export; as is a finer kind at Toulon Island by the dark race. This shows that both races engage in manufacturing industry for the express purpose of trading with the products, a thing of happy augury for their future progress.

My second trip to New Guinea included visits to the Louisiades, to Woodlark Island, to Rook and Long Islands, and to the mainland near Cape King William. The Louisiade people are in physique and knowledge of the arts inferior to both races of Southeastern New Guinea. Many of them are quite unfamiliar with white men. But I found, even among them, some who had heard of Queen Victoria, a name which is so frequently known and so greatly respected throughout the Southwestern Pacific that the stranger is fairly astonished. A native of Joannet Island intimated that he was aware that Queen Victoria was the chief of Cooktown, the little port in Northern Queensland. On Rossel Island I noticed, in the case of some of the men, the curious dentition which the eminent Russian traveler, Dr. Miklukho Maclay, has called "macrodontism." A continuous tooth extends over the space usually occupied by two or three teeth. The Woodlark-Islanders are very fierce, and at one time I thought a collision with them inevitable. They make the same curious gesture of salutation as the Basilaki (or Moresby) islanders, pinching first the nose with one hand and then the navel with the other, finishing up with a low bow.

The natives of the northeast coast of New Guinea whom I met were black, and not superior in physique to the Louisiade people.

While in the south of New Guinea the natives are in the stone age, these people have not got beyond the period of shell implements. They could hardly be made to understand the use of a tomahawk, and were frightened by striking a match.

The Rook-Islanders seemed never to have seen a white man. Smoke coming out of the mouth of an officer with a pipe greatly surprised them. A chief on being brought up to a looking-glass was struck dumb. The exhibition of a cat caused great excitement, which was immensely increased by showing them a sheep. They are a light-colored, tall, good-looking race, who express great repugnance to cannibalism. They build good houses and temples, have well laid-out villages, and possess large highly painted canoes ornamented with carvings. They practice circumcision, and an incised figure of an alligator adorns the entrance to their temples. Their reception of my companions and myself was courteous and friendly in the extreme. One of the officers of her Majesty's ship Dart was a good conjurer, and the delight with which the disappearance of a coin through the bottom of a tumbler was hailed by the natives was intense.

A few observations on the condition of the Southwestern Pacific may not be out of place. I believe that the members of even the most savage tribes desire to be on friendly terms with white men. There are some tribes who, in pursuance of the barbarous custom of taking heads, will make unprovoked attacks on white visitors. But they are comparatively rare exceptions. I fear that most of the so-called "outrages" are to the natives what the retaliatory action of ships of war is to us. We regard the latter as the proper punishment of an offending tribe; and the islanders look upon the killing of a white man—if any white man has done them an injury—as much the same thing. Events have proved that the old practice—for years given up by us, but still followed by some European nations—of the wholesale punishment of the people of an island charged with an "outrage" does nothing to improve relations with the islanders. The plan of punishing only the really guilty has been far more successful, and when that is universally adopted the friendliness of our relations is sure to increase.

The diminution of population is one of the mysteries of the Pacific. It has perhaps been arrested in Feejee. Time will show if the stoppage is permanent. On the small Wallis Island under the Catholic, and Niué, or Savage Island, under the Protestant missionaries, the people increase; elsewhere, whether Christian or savage, they diminish. It is common for natives to speak of the greater numbers of their tribes in former days, and there is evidence to support their assertion. Can it be that the islands of the Pacific have been the seats of a succession of races, all of which have at a certain period in their history declined and disappeared, and that our acquaintance with the present inhabitants only began when the declining stage had been reached? The

suggestion is made with timidity, but I confess that I sometimes fancy that something like it may explain the existence of the curious ruins so widely scattered throughout Oceania.

The Pacific islands can not be mentioned without calling to mind the missionaries who labor among them. Their success has been very great; but, great as it is, I think its magnitude has been exaggerated. The Christianity of the Western Polynesians is not much to boast of; and their present state of civilization is much more owing to frequent intercourse with white men who are not missionaries than is generally admitted. Without missions they would not have advanced so far as they have done; nor with them would the advance have been what it is had no other white men ever gone among them. The same thing is true of Feejee. Some of the "pioneer" missionaries are men of whom every country might feel proud. The influence for good of such men as Mr. Moulton, of Tonga, or Mr. Robertson, of Erromanga, is enormous; but they are men of enlarged views and of even statesmanlike capacity, who would be powerful over their fellows anywhere. The same may be said of Messrs. Lawes and Chalmers in New Guinea, and will explain to a great extent their astonishing success. Mr. Chalmers is a born leader of men, and his ascendency over those with whom he is brought in contact is due to a never-failing tact and a nobility of mind which have been rarely equaled.

It is hazardous to forecast the future, but it does not seem that the Pacific islands are likely, for generations yet to come, to be of use to mankind at large. Fertile as they may be, they can only be made productive with labor, of which no man can say where it is to be obtained.

## SOME OUTLINES FROM THE HISTORY OF EDUCATION.

By W. R. BENEDICT,

PROFESSOR OF PSYCHOLOGY AND LOGIC IN THE UNIVERSITY OF CINCINNATI.

[*Concluded.*]

THE institution at Dessau made distinct approaches to object-teaching. It remained for Pestalozzi, however, to give this method philosophical expression and justification. We know how the Pestalozzian idea has been enlarged and improved by Froebel and his followers. Our present purpose is to trace this idea in its beginning and development under Pestalozzi.

The reformer was born January 12, 1746, at Zürich. His first attempts to serve the people were of a literary character, and this as member of the staff of a political newspaper published for the improvement of the masses. He then entered the ministry and made an

attempt to preach. After a pastorate even shorter than those of modern times he applied himself to the study of law. Over-work compelled him to seek rest in the country. Here he soon entertained the purpose of becoming a farmer, because he believed that in this way he could best work for the culture of the farmers. The aim of his life seems justly set forth in these words: "To bring about a better destiny for the poor in the country, by a firm establishment and simplification of their means of education and instruction." His agricultural undertaking at Neuhof was a failure from the beginning. Meanwhile he opened an orphan asylum, and undertook the care of fifty parentless children. The time came when there was neither bread nor wood. Then eighteen years of waiting—of worse than waiting, of reproach and increasing self-distrust, verging close upon despair. In 1780 Pestalozzi published "The Evening Hours of a Hermit," setting forth his educational doctrine in most suggestive phrase. A year later came "Lienhard and Gertrude"—a book for the people. This was written in a few weeks, and, as Pestalozzi says, "without my knowing how I came to it. I felt its worth, but only as a man in a dream feels the value of a blessing. I saw the degradation of the people, and 'Lienhard and Gertrude' was a sigh over this degradation." It was fundamental with Pestalozzi that the education of the child should commence, as it were, at the first instant of life. "By the cradle must we begin to wrest from the hands of blind Nature the guidance of our race, that we may place it in the hands of that better power which has taught us by the experience of centuries to reflect upon the nature of her eternal laws."

During the winter of 1793–'94 Fichte gave lectures or discussions in Lavater's house. Pestalozzi was led by these interviews to write his second great work, entitled "Inquiries concerning the Course of Nature in the Development of the Race." Events soon called the reformer from writing to practical work. War, with its orphans, came into the valleys of Switzerland. An orphan asylum was opened near Stanz. Pestalozzi, already fifty-one years of age, took charge of this asylum. Very touching are his words: "I had gone to the most secret clefts of the mountains to find my work, and truly I found it. But think of my condition! I, alone—deprived of all appliances for education—I alone overseer, keeper of accounts, house-servant, in an unfinished house, among evils of all kinds. The children numbered about eighty, all of different ages, some in open beggary, all entirely ignorant. I stood in their midst. I repeated sounds to them, made them give the sounds after me. All who saw it were astonished at the result. It was really the pulse-beat of the art which I sought. I did not know what I was doing. I knew upon what I had resolved—death, or the accomplishment of my purpose."

Pestalozzi found a more permanent resting-place at Yverdun. The institution which was established here continued from 1805 to 1825,

and became most widely celebrated. "In 1809 the school contained fifteen teachers and one hundred and sixty-five students from Germany, France, Italy, Switzerland, Russia, and North America." Here, as elsewhere, jealousy did its deadly work. The teachers quarreled for Pestalozzi's favor. In 1816 twelve teachers left the institution, and there was no help against the disorder. On the 17th of February, 1827, Pestalozzi died, these being his last words: "I forgive my enemies. May they now find peace! I go to eternal peace."

In outlining Pestalozzi's thought, I note the following points as perhaps best expressing his method: Education must be determined by the nature of that which is educated. Man is a law unto himself. What he is dictates the mode in which he shall be trained. Man's powers are not the result of accident—they are his own interior, original possessions. They came with him. Education, therefore, which does not base itself upon a right understanding of these integral human powers, and of the nature which they express, is not education—has no right to the name or the claim. Pestalozzi, by stating this truth, and by forcing it, as it were, into the world's consciousness, deserves lasting praise. Here is the first step toward a scientific treatment of education; it is not, in itself, such treatment, does not even prove such treatment possible—it is the point of beginning, the corrective, the safeguard. This truth is fundamental in Pestalozzi's thought. It found expression in "The Evening Hours of a Hermit," and is repeated in every subsequent writing. "Universal upbuilding of the inner powers of human nature is the universal aim of culture." Pestalozzi's system, therefore, when self-consistent, rests upon his interpretation of human nature. Our reformer believed man to have a threefold being. He was body, mind, and conscience. It is a vital part of Pestalozzi's thought that man's welfare depends upon a good and truth-obeying heart. Here is place for the religious element, and we find Pestalozzi speaking as follows: "Belief in God is the source of peace, peace is the source of inward order; inward order the source of undisturbed application of our powers, and this order becomes, in turn, the source of their growth and development to wisdom. Wisdom is the source of all blessing." We have thus far two essential factors in Pestalozzi's thought: education is determined by the nature of the educated—man is threefold, body, mind, and heart. Proceeding a step further we inquire, What precisely is it that this threefold being requires? Do body, mind, and conscience unite in demanding for their education a single method? Pestalozzi answers yes, and affirms that the common, universal law, is *development*. To-day we theoretically recognize this law, and admit its vital import in all educational endeavor; practically we too often ignore it, and proceed after the old and evil fashion of preparing the mind for market as the animal is prepared for sale. There was a time in the slowness of history when this very principle of development was unknown, a time

when education was confounded with fact-knowledge. Pestalozzi found an illustration in the tree. Who can educate a crab-apple tree into a peach-tree? A crab-apple tree can be made a better crab-apple tree perchance, a peach-tree can be made a better peach-tree by development, by assisting the natural processes, by warding off destructive forces. Development must take place by assimilation of food. This is true for body, mind, and spirit. Around about man lies his food. Nature furnishes material for man's education. That is his development. Pestalozzi saw this, and he saw no less plainly that the material might hinder the development. Improperly given food will destroy life. There must, then, be a law for this development process; assimilation must proceed properly, or all will fail. *The subject-matter of education must receive its law from the course of the development process.* How does man unfold his powers? What is the order given here by man himself? Pestalozzi's answer brings us face to face with the essential characteristic of his method. Man unfolds his powers by beginning with sense-perception, with "Anschauung." This German term is nearly as untranslatable as the word "Gemüthlichkeit." Sense-perception covers perhaps the larger portion of the meaning, yet does not include it all. Anschauung signifies that clear discernment of an object which is given by direct face-to-face acquaintance. Man's development begins exactly here with such perception. This is the basis of all knowledge. The degree of intensity, the clearness, the comprehensiveness, the order of this perception, must be decisive respecting each individual's education. Pestalozzi says, "When I look back and ask myself what I have really accomplished for education, I find I have settled it that the fundamental principle of instruction lies in the recognition of perception as the absolute basis of all knowledge." This principle originates and philosophically justifies object-teaching. Perception has a law or method; standing at the bottom of education, perception leads naturally up in orderly gradation to that which is higher. Perception must be reduced by definite and psychologically arranged exercises to a perception science. When giving instruction, we must see to it that the objects are examined by the child one at a time, and not in the dim distance, but close at hand. We must see to it further that characteristic illustrations are brought forward, not any abnormal representations. From the perception of a thing arises its name, from the name we advance to an enumeration of its properties; from this we finally develop the definition, the clear idea. Here is the philosophy of object-teaching. Let the child see. This seeing must be something far greater than any general vision; it must be a seeing arranged according to a strict psychology. Pestalozzi worked out a system of object-teaching, or a psychology of perception. We have place for but the briefest statement: "The entire sum of all the external properties of an object is found within the object's circumference and in the relation of its number, and is made known by

speech." Therefore the art of perception must start from this threefold basis—number, form, and speech. We must teach each object to the children as unity, separated from all with which it may seem to be bound. We must then teach them to observe the form of every object, that is, its measure and relations; lastly, we must make them acquainted with the entire circle of the words and names for the objects which they know. It would be of little service to follow Pestalozzi further in this direction. The arrangement of natural phenomena under form, word, and number, contains the fatal error of incomplete classification. There can be no question that form and number are modes of things, but this is a seriously inadequate account of Nature's manifestations. The supreme fact which the world teaches, and which thrusts itself upon us every hour of every day, is the fact of causative energy. Nature's great truth is cause and effect. Pestalozzi took little or no account of this, and consequently dealt with the form and number of objects, to an exclusion of the objects themselves. Pestalozzi had no place for chemistry, or physics, or physiology. Here lies the absurdity of object-teaching as often presented. He who fails to see Nature *at work* misses the organizing principle of her manifestations, and can not teach according to Nature. The principle of object-teaching wac fundamental with Pestalozzi. As concerns this distinguishing feature of his thought, we would say that, because perception is the first step in the unfolding consciousness of a child, it does not follow that perception should be made *supremely prominent* in the education of the child. Were the child to remain a child, we should have regard solely to those things which might exercise his childish faculties. Since the child is to pass from childhood to manhood, it is well to have care lest over-development of the child-method tend to perpetuate a childish habit of mind.

Pestalozzi distinctly admits that the *idea*, not the vision, is the distinguishing mark of human reason. He repeatedly says that the child must be brought on to a full possession of the general notion, the concept. If, then, we make object-teaching, or the gaining of distinct sense-impressions, the *exclusive* work in all early training, we stand in danger of prolonging this childish state, and of failing to furnish the mind with clear, independent ideas. Directly, or indirectly, the movement now under consideration is responsible for one of the greatest evils of our time. I name this the pictorial disease. *Everything* must be depicted.

Literature, forgetting that grown men and women ought to be able to think, treats them as children, and illustrates. It has come to pass that we can not read a strong article or a strong book. Everything is diluted with pictures. Let me not be misunderstood. True art is the painter's poem—the hero's deed. True art is no illustration, no picture, no copy of Nature. It is Nature herself, as she has taken up her abode in the artist's mind and heart. Here is one who will paint you

grass so that you shall think it *is* grass, and go to put your hand upon it. Here is one who will paint you no grass, but bring a green field with soft breezes playing over it, sweet odors rising from it, life dwelling in it; and this one is the artist. His language is no illustration, no picture, but something far higher, even an actual creation. The fundamental command of Pestalozzi, proceed vision-wise, is susceptible of exaggeration. Too literally obeyed, this command is harmful in all departments of human activity. This thought has wide application. It lies against all *exclusively* physical training, all training depending solely upon material objects. There is great danger lest such training keep the student from clearness of vision in *the eye of the mind.* He sees things, but, unless things lead to independent thoughts, they are nothing more than pictures upon the retina of flesh. Our thought is applicable to classical education, in so far as words become the objects and are studied as mere things. Latin and Greek, taught as *vital* parts of language, are, even in their minutest particles, so many expressions of the mysterious and indestructible power of thought. Pestalozzi's teaching that the clear idea is *the result* to be secured by education is unquestionably true. Man proceeds from sense-perception to concept when he proceeds normally. The end, however, is often lost sight of in the means; the idea is not realized because the object, the matter, the substance, is too prominent, too permanent, too overbearing.

The writer hopes that not the least result of this historical survey has been to set forth Pestalozzi's fundamental principle as a controlling power in the educational development of the past. Man not only should give law to his education, he has done so. The education of China was the Chinese interpretation of man; the education of India was the Indian interpretation of man; the education of Greece the Grecian interpretation of man; and the new education of to-day is our interpretation of man. Has man's nature been taken at its entirety by any educational scheme of the past? Is man's nature taken at its entirety by the educational system which to-day claims precedence and finality?

We have seen man, the grown man, as a child: this was and is China. We have seen man as member of a caste, belonging body, soul, and estate to his order: this was and is India. We have seen man a Grecian or a Roman, self-conscious as a Grecian or Roman, not self-conscious as man. We have seen man a contra-natural member of a contra-natural church: this was the monk type of the perfect man. We have seen man, not satisfied with such interpretation of his nature, go back to Greece and Rome, finding in Demosthenes and Cicero the ideal being. To-day we see man as the producer, the builder, the one who brings things to pass.

In these "outlines" very much of importance has been omitted. This concluding paper does not make place for the things that were

neglected. The very recent appearance, and for the first time in English, of "Histories of Education," offers excellent opportunity for that detailed and thoughtful consideration of our subject which its importance demands.

We pass to a brief consideration of Mr. Spencer's work on "Education, Physical, Intellectual, and Moral." This title gives plain recognition of the fact that education is threefold because man is threefold. Mr. Spencer's treatise originally appeared in four review articles, as follows: 1. "What Knowledge is of most Worth?" 2. "Intellectual Education." 3. "Moral Education." 4. "Physical Education." It may be allowable to preface our remarks upon Mr. Spencer's teaching in these papers with some expression as to its value. We would vote to-day for compulsory legislation which should see to it that every parent and instructor and rational person read Mr. Spencer's articles on education, and then read them over again, and then studied them, and then practiced such portions of their teachings as we accept. Without doubt, the bearing of this last clause is all too apparent; but, as it is needed for the fair expression of our conviction, it shall remain unaltered.

Mr. Spencer has discovered that pigs, sheep, and horses are better taken care of than children. There is more and better science applied to the physical well-being of pigs than to that of our own race and kindred. Mr. Spencer states the desideratum in physical education as follows: "To conform the regimen of the nursery and school to the established truths of modern science."

"Without calling in question the great importance of horse-training and pig-feeding, we would suggest that, as the rearing of well-grown men and women is also of some moment, the conclusions indicated by theory and indorsed by practice ought to be acted on in the last case as in the first."

I quote at this point one of those paragraphs which would secure a vote for the compulsory legislation before mentioned: "There is a current theory, vaguely entertained, if not put into definite formula, that the sensations are to be disregarded. They do not exist for our guidance but to mislead us, seems to be the prevalent belief reduced to its naked form. It is a grave error. We are more beneficently constituted. It is not obedience to the sensations, but disobedience to them, which is the habitual course of bodily evils. Perhaps nothing will so much hasten the time when body and mind will both be adequately cared for as a diffusion of the belief that preservation of health is a duty. Few seem conscious that there is such a thing as physical morality. Men's habitual words and acts imply the idea that they are at liberty to treat their bodies as they please. The fact is, that all breaches of the laws of health are physical sins. When this is seen, then, and perhaps not till then, will the physical training of the young receive all the attention it deserves." In his paper on "Intellectual

Education," Mr. Spencer presents a series of contrasts between past and present education. From an extreme in physical education followed an extreme in mental education—we are now learning the value of being good animals. Learning by rote or memory is passing away. Learning by rules is disappearing. From this has resulted the postponement of once earlier studies to a later time. This also is decidedly by way of contrast. We have reached object-teaching or culture through observation. Again, we present truths in the concrete, not in the abstract. The seventh and last contrast is shown by the desire we manifest to make all acquirement of knowledge pleasurable. Mr. Spencer calls attention to the common characteristic of these contrasts, viz., an increasing conformity to the methods of Nature. This leads to Pestalozzi's teaching that education must adapt itself to the natural process of mental evolution. After these special considerations, Mr. Spencer announces certain principles which may serve as guides in the matter of intellectual education until the establishment of a rational psychology. "Proceed from the simple to the complex. Begin in the concrete and *end* in the abstract. Education must accord, both in mode and arrangement, with the education of mankind considered historically. Education should proceed from the empirical to the rational. Self-development should be encouraged to the fullest extent. The method of instruction should create pleasurable excitement."

Education is to provide for man as a threefold being. The *intellect* must work upon *all* the material offered for development, must convert this material into organized knowledge. We now reach a subject that has been thought by almost *all* educators to present the question of questions, viz., What subject-matter is best adapted to unfold the complex nature of man? While I regard the high importance thus attached to this question as entirely beside the mark and a serious hindrance, I know that the matter can not be ignored. On all hands people seem constrained to reform education by determining *what* shall be taught. Let us note, for a moment, the forms of intellectual activity engaged in the acquisition of organized knowledge. These may be phrased as discrimination, detection of identity, and reproduction, both direct and creative. For the natural, proper action of these powers, *the material is a matter of comparative indifference.* I can analyze, synthesize, and remember, whether I deal with Latin, Greek, mathematics, chemistry, literature, or strictly speculative philosophy. That department which presents the largest number of facts, *best classified,* will offer most opportunity for the action of the intellect. In all effort to educate, therefore, we should present that branch or those branches only which contain the most facts in the best order.

There was a time when it might have been fairly said that *the classical languages alone* met the necessity just indicated. After middle-age scholasticism had worn out the patience of men, and be-

fore scientific discovery pointed to better things, there was naturally and necessarily a return to ancient Greece and Rome. The direction thus given to education could not but bring it to pass that the facts of the Greek and Latin languages should be both the most numerous and the best classified of any facts in the possession of men. The study of Greek and Latin was a way of deliverance from scholasticism, and as such was best calculated to educate the entire man. We see the historical and rational ground for that supremacy which was enjoyed by the classical languages in all educational undertakings. This supremacy, resting on most facts best classified, would necessarily give way before any other subject-matter presenting an equal or greater number of facts as well or better classified. Now, it is a claim unqualifiedly put forth by those able to judge, that the physical sciences offer more facts under better classification than do Latin, Greek, psychology, ethics, history, or any other non-material study. This is a simple question of fact, if, indeed, it be a question at all. Allowing the claim, we shall conclude that the physical sciences have full right to take their places by the side of the classical languages *so far as promoting the activities of the intellect is concerned.* This disposes of the question of discipline. To analyze, synthesize, and remember, is to organize knowledge. When full opportunity is given for such mental operations the requirements of mental discipline are realized. Education, however, is something more than mental discipline. Education is the development of man's complex nature. When we discuss the question of material, therefore, we must discuss it in the light of man's nature. The question as to the *relative value of knowledges* Mr. Spencer considers in his first article, and he does so, be it carefully observed, from a different education-idea. He says, "To prepare us for *complete living* is the function which education has to discharge." I would amend this, and say, to prepare us for complete *being*, complete *becoming*, is the function which education has to discharge. Here is not a distinction without a difference. Had Mr. Spencer's language stood isolated from the rest of his article, it would have been possible to find in his words, "complete living," what is contained in the words "complete being." Connected, however, with Mr. Spencer's classification of human activities, with the principle on which this classification is based, and with the whole tenor of his article, the "complete living" presents, as it is intended to present, the practical, physical idea. Man is viewed as the producer, the one who brings things to pass, the one who adjusts himself to his environment. I remember all that Mr. Spencer has said about yielding to no one in his estimation of æsthetical development, but I also remember these words: "As the fine arts occupy the leisure part of life, so should they occupy the leisure part of education"; and these words: "Here we see most distinctly the vice of our educational system; it neglects the plant for the flower," which may be true, and the supreme value of the flower

remain unimpaired. Mr. Spencer believes that man's nature should be unfolded for the sake of making him a complete liver—we believe that man's nature should be unfolded *for its own sake*, for what there is in it of power for goodness, for what he, the man, can become by loving reality and by serving his fellow-beings. These ideas are essentially different; as much so as the *culture*-idea of humanism and the useful idea of philanthropism. It should be understood, however, that we are not restating, in slightly different language, this culture-idea which humanism advocates. The word culture labors under the misfortune of being either too indefinite or too narrow. It means nothing, or it stands for general æsthetical development. The cultured man is thought of more from the side of mind and taste than from the side of moral excellence. The true education-idea embraces the development of the *entire* man, and any system which aims at else than this or less than this is defective in theory, and will be defective in practice. Let us interpret Mr. Spencer's language, not in itself alone, but in its connections, and as related to the entire course of his argument. "How to live—that is the essential question for us; not, how to live in the mere material sense only, but in the widest sense. The general problem, which comprehends every special problem, is, the right ruling of conduct in all directions, under all circumstances: in what way to treat the body, in what way to treat the mind, in what way to manage our affairs, in what way to bring up a family, in what way to behave as a citizen, in what way to utilize all those sources of happiness which Nature supplies; how to use all our faculties to the greatest advantage of ourselves and others; how to live completely; and this, being the great thing needful for us to learn, is, by consequence, the great thing which education has to teach." By the aid of this fundamental position Mr. Spencer sets forth the kind of material which he believes best qualified to educate man. "Our first step is to classify, *in the order of their importance* [italics the writer's], the leading kinds of activity which constitute human life." Mr. Spencer gives the following classification: I. Those activities which directly minister to self-preservation. II. Those activities which, by securing the necessaries of life, indirectly minister to self-preservation. III. Those activities which have for their end the rearing and discipline of offspring. IV. Those activities which are involved in the maintenance of proper social and political relations. V. Those miscellaneous activities which make up the leisure part of life, devoted to the gratification of the tastes and the feelings." This classification, so far as it is to be made the basis of educational endeavor, I can not but regard as fundamentally defective. *It proceeds from a confusion of primary necessity with primary value.* Mr. Spencer, in commending his classification, says, "The actions and precautions by which, from moment to moment we secure personal safety, must clearly take precedence of all others." Admitted, on a proper interpretation of this word *precedence.*

I must know that poison, in certain quantities, will destroy me. Is this knowledge, *therefore*, more valuable than other knowledge?

"The power of self-maintenance necessarily preceding the power of maintaining offspring, it follows that knowledge needful for self-maintenance has stronger claims than knowledge needful for family welfare, is second *in value* to none save knowledge needful for immediate self-preservation." Because I must know how to secure bread and potatoes, nay, more, because I must actually secure them, before I can support a family, is this bread and potato knowledge therefore *in any sense* more valuable than that knowledge of moral requirements which might help to make me a good father, a proper guide, and loving companion to those who should look to me for protection? Mr. Spencer further says: "Those various forms of pleasurable occupation which fill up the leisure left by graver occupations—the enjoyments of music, poetry, painting—manifestly imply a pre-existing society. And consequently that part of human conduct which constitutes good citizenship is of more moment than that which goes out in accomplishments or exercise of the tastes; and, in education, preparation for the one *must rank before* preparation for the other." What do these words "rank before" mean? Before in *necessity?* Yes. Before in value? No. Because we must be civilized before we can develop our æsthetical, our moral and religious nature, *therefore* civilization is more valuable than the flower of spirituality? The rose must have its roots and body, must have them well trained and cared for; *therefore* the roots and body are more valuable than the opened bud with its wealth of color and fragrance. Let us hold clearly in mind Mr. Spencer's teaching as to the proper subordination of material in education. First should come that education which prepares for direct self-preservation; second, that which prepares for indirect self-preservation; third, that which prepares for parenthood; fourth, that which prepares for citizenship; fifth, that which prepares for the miscellaneous requirements of life. How shall this order be applied? "Of course, the ideal of education is complete preparation in *all* these divisions; but, failing that, the aim should be to maintain *a due proportion* between the degrees of preparation in each. And what is due proportion? It is an attention *greatest where the value is greatest, less where the value is less, least where the value is least.*" Take this language in connection with the following sentence: "For the average man, we say, the desideratum is a training that approaches nearest to perfection in *the things which most subserve complete living*, and falls more and more below perfection in the things that have more and more remote bearing on *complete living.*" Here we draw near Mr. Spencer's meaning in the words "complete living." Complete living is more to be sought in self-preservation than in the creation of a poem, the production of harmonies, the luxury of benevolence. Man, Mr. Spencer himself being judge, is a threefold being,

having body, mind and spirit. Why should we, in educating him, take least thought for the flower? Why should we take less thought for the flower than for the roots? Because without the roots there can be no flower? But so also *with* the roots it may chance that there shall be no flower. There is many a splendid body with soul so small that Omniscience scarce could find it. If we look *primarily* to the roots, think constantly of the roots, make the roots uppermost in all endeavor, we shall develop roots and nothing else. Existence is, indeed, a struggle. Shall we not, then, educate men for their immediate task? Most certainly. Shall we forget, or put at all into the background, the fact that men have a spiritual nature, and that in this lies their highest and fullest measure of being? This, to some, may savor of cant and of the seminaries. Let it, however, be settled, apart from sects or creeds, whether there are such excellences as *sincerity*, purity, truthfulness, self-forgetfulness in the desire to be and to do good. Let it also be settled in what relation these stand to the other excellences of man's nature. Let it be seen whether they are not supreme in the sense of *making up his worth*, in the sense, that is, of giving value to all his other attainments, physical and intellectual. These important matters being settled in the affirmative, as very many would settle them even in our so-called materialistic age, education would at least proceed in a *different spirit*. While it would not be the business of education to make men and women good, it would be impossible to call those educated who had never so much as thought on goodness, or never considered themselves in the light of their highest possibilities and duties.

With respect to the subject-matter of education Mr. Spencer offers this delicious bit of satire: "Men who would blush if caught saying Iphigēnia instead of Iphigenīa show not the slightest shame in confessing that they do not know where the Eustachian tubes are located, what are the actions of the spinal cord, what is the normal rate of pulsation, or how the lungs are inflated." This sentence may be turned about and made to utter truth as follows: Men who would blush in not knowing where the Eustachian tubes are located, what are the actions of the spinal cord, what is the normal rate of pulsation, or how the lungs are inflated, show not the slightest shame, not the very slightest shame, in confessing that they do not know when Plato lived or what he thought, when Goethe lived or what he thought, when Angelo lived or what he wrought. The entire duty of man is not to locate the Eustachian tubes. The entire duty of man is not to know the actions of the spinal cord, or how the lungs are inflated—not one particle more than it is his entire duty to say Iphigenīa. It is not *what* a man knows, but *how* he knows what he knows, that determines the character of his education. This thought, in the writer's opinion, is fundamental. To lead up to it and to give it full emphasis has been the special object of all remarks here made upon Mr. Spen-

cer's teaching concerning the relative value of knowledges. It was not expected that any argument with regard to his position in this matter would have weight for those who, of necessity, that is constitutionally, accept his opinions. As was shown in the contrasts between humanism and philanthropism, the antagonism rests upon a sharply defined natural dualism. Man is a creature of opposites. It is perfectly competent to say to him *be good;* it is also perfectly competent to say to him be good *for something.* Argument may not hope to obliterate this distinction. The "Andover Review," June, 1886, contains three notable articles bearing on the present phase of our subject. These are: "The Group System of College Studies in the Johns Hopkins University," by President Gilman; "The Harvard New Education," by Professor Howison; and "Individualism in Education," by Dr. Denison. President Gilman shows that Johns Hopkins has, from the first, recognized the thorough-going distinction between a college and a university. "The idea that university education should be based upon collegiate training is generally admitted—except in the United States. This distinction the authorities in Baltimore have endeavored to emphasize. From the beginning, the plans included collegiate instruction for those who were not ready for graduate work." In attempting to provide college courses the old difficulty of the "curriculum" was encountered. Johns Hopkins met this difficulty by an intermediate course. Several parallel schemes were arranged which were of equal length and assumed to be equally difficult. They led to the same degree. They were spoken of as equally honorable." It is surprisingly interesting to note the studies found in *all* these courses. They are "logic, ethics, and psychology; physical geography and history; English, French, and German; a laboratory course, for at least one year; and also physical culture, vocal culture, and drawing." That the Johns Hopkins University should require of *all* its undergraduate students such studies as logic, psychology, and ethics, must seem a trying thing to many of the younger materialists. That these subjects should be given preference over Latin and Greek as furnishing a culture *required* for *all* undergraduates can not but seem incredible to thousands of classical instructors. President Gilman, expressing his own opinion of the plan, says: "I am far from thinking that the group system here devised is perfect, even for our requirements. It is constantly studied and frequent efforts are made to improve it. But, as far as I know, the instructors in this university are unanimous in thinking that it is the only method practicable for us to adopt. We should doubtless differ very much from one another in our estimate of the different courses, and *we should be likely to counsel young men differently as to their selection.*" This sentence suggests the question whether the entire scheme is not more largely the result of compromise than of mutual conviction and agreement. That a large body of instructors

should agree upon such prescribed studies as above set down, for *all* undergraduate students, will not find ready credence. The movement at Harvard which is now phrased as the new education, though an extreme, is perfectly natural, and easily lends itself to such brilliant advocacy as that of Professor Palmer: "The old conception had been that there were certain matters, a knowledge of which constituted a liberal education. Compared with the possession of these, the temper of the receiving mind was a secondary affair. Under the new conditions college faculties were forced to recognize personal aptitudes. In assessing the worth of studies, attention was thus withdrawn from their subject-matter, and transferred to the response they called forth in the apprehender. Hence arose a new ideal of education in which temper of mind had pre-eminence over *quæsita*, the guidance of the powers of knowing over the store of matters known." Nothing could well be found more admirable than the reply of Professor Howison to this paragraph. So far as a recognition of the needs of human nature is concerned, he seems to meet the case completely: "Study can not be liberalizing unless it is pursued in a temper of freely dutiful diligence, but no more can it be so if it does not put its subject in possession *of the constitutive fibers of civilization* [italics present writer's]. Our life in humanism is linked by vital threads to the growth of the past as well as to the environment of the present—threads that can not be severed except on penalty of spiritual death." We inquire how shall the student be put in possession of the "constitutive fibers in the historic substance of civilization"? In reply, Professor Howison gives *his* curriculum for all undergraduate study:

"Languages, classical and modern; mathematics, in all its general conceptions, thoroughly apprehended; physics, acquired in a similar manner, and the other natural sciences, though with much less of detail; history and politics; literature, especially of the mother-tongue, but indispensably the masterpieces in other languages, particularly the classic; philosophy, in the thorough elements of psychology, logic, metaphysics, and ethics, each historically treated, and economics, in the history of elementary principles, must all enter into any education that can claim to be liberal."

This is, indeed, a "liberal" course of study, but no amount of argument could persuade a large number of our educators, or of our average citizens, to *insist* upon such a course for *each student*. If here alone be a liberal education, many would say, so much the worse for a liberal education; we will have none of it. To compel a boy, who has absolutely no natural disposition for it, to spend his years in groans over mathematics or classics, or psychology, logic, metaphysics, and ethics, would be a matter calling for action from the Society for Prevention of Cruelty. And yet the writer is in direct sympathy with the position of Professor Howison. The writer believes that these are

the constitutive fibers of civilization, and would have them wrought into every young man or woman who might seek an education. Nevertheless—and this is the point of all our urging—*true reform in education can not be found on this path.* Agreement as to the subject-matter of study is an impossibility. All judgment on this point roots itself in the constitution of the individual, and, while many may agree that the topics named above compass the circle of being, they will not agree as to the desirability, much less the *necessity*, of demanding years of toil in such topics from each young man and woman. Professor Howison believes that "thoughtful and competent judges—outside of the Harvard circle—will stand by the plainly reasonable conviction that there is a sum of knowledge touched with sentiment, and invigorated by masterly grasp, the lack of which demonstrates the lack of a truly cultivated mind." This is most admirable. But who are the thoughtful and competent judges? And, when they have been found, who shall assure us that their curriculum will be that of Professor Howison? From the nature of human nature there can not be such agreement. *Individuality* is as much a constitutive fact of each human being as is the trait which he shows in common with his fellows. This individuality, representing his inheritance, his childhood, his training by environment, *will* assert itself. And this means nothing more or less than that he, the given person, will go out toward certain subjects and withdraw from others. Force him to study Latin and Greek, or mathematics and physics, even through the college course, and you may do him irreparable harm. At all events, there is here an open question. The writer believes it will remain an open question until the time of the perfect psychology. Meanwhile the course of education can be advanced, and that on another line. *This is the line of better teaching.* One of the most important truths contained in Mr. Spencer's treatise is found, as I think, in the following paragraph: "A branch of knowledge which, as commonly taught, is dry and even repulsive, may, *by following the method of Nature*, be made extremely interesting and profoundly beneficial. We say profoundly beneficial, because the effects are not confined to the gaining of facts, but often revolutionize the whole state of mind." A more pregnant sentence with regard to education can not be found. To follow the method of Nature in teaching a given subject means to recognize the *special* character of the subject itself, and at the same time to discern its *natural place in the unfolding being of the pupil.* The first secures the organic presentation of the subject *per se*, the second finds in the pupil a natural—i. e., a constitutive—response to the matter as developed. The business of teaching is to *establish relations*, not to communicate facts; these relations are between the being of the pupil and subject studied. That there are, for *all* subjects, such relations, that these relations are, *in all cases*, natural, must be the guiding conviction with every teacher. Instead, then, of

attempting to reform education by "devising courses," by finding out new things, by contesting the supremacy of this or that branch of knowledge, does it not seem wiser to insist upon *right teaching?* Subjects as doleful to the common student-mind as Latin grammar, Greek grammar, formal logic, psychology, and ethics, have been made "to revolutionize" the whole state of being for many a pupil, and this by right teaching. All knowledge is worthy—worthy the best of human endeavor, both to secure and to communicate. Let us, then, pass from this as from a matter not needful longer to be discussed, and demand *true teaching.*

## THE PHYSIOLOGY OF ATTENTION AND VOLITION.

By JAMES CAPPIE, M. D.

"GIVE me a fulcrum," cried the ancient sage—"give me a fulcrum, and I shall move the world." "Grant me a few postulates," says the modern reasoner, "and I shall read you the riddle of the universe." An unchallengeable postulate, however, is almost as difficult to find as a stable extra-terrestrial fulcrum. The scientific "spirit of the age" walks by sight and not by faith. It revels in facts. It numbers, and weighs, and measures; it catalogues and describes; it compares and classifies. To make progress among the secrets of Nature its highway is experiment, and its watchword is demonstration. For any interpretation of a natural phenomenon it demands proofs that can appeal to the senses, and it looks with wholesome suspicion, if not contempt, on mere "arm-chair" speculation.

The marvelous success in advancing knowledge, and in gaining power over the forces of Nature that has resulted from its use, is convincing evidence that the scientific method of interrogation is sound, and that it should always be adopted wherever possible. But it is not always possible to apply the method. The nearer we approach the region of subjective phenomena, the more difficult it becomes to test particular interpretations by an appeal to experiment. The galvanometer may reveal agitation in a sensory surface, but it tells nothing about sensation. The convolutions of a dog's brain may be tampered with, but he will not describe to us his feelings. Consciousness alone can discriminate the facts of consciousness; and the character, or succession, or relation of these can only be described in terms of metaphysic. Theories of physical relationship here must at first be tentative, and at the best they will require to be stated in very general terms. The argument must consist in the application of general principles; and, in choosing these, analogy balanced by common sense must be our guide. In drawing our conclusions, we may be satisfied if these can be held with some moderate degree of probability.

In attempting to gain a closer view of the somatic relations of mind,

my subsequent argument will rest on the assumed correctness of three postulates. The first of these is, that every manifestation of mind is correlated to a definite mode and sphere of brain activity. This may be emphatically insisted on, whatever be the view taken as to the nature of mind itself. For, to take the illustration so frequently made use of —that of the relation of a musician to his instrument—the volume and quality and harmony of musical sounds are immediately correlated not to the fingers of the player, but to the tremors within the instrument. So the outcome of mental action, even as revealed to one's own consciousness, is not simply the result of some ideal, self-acting energy asserting itself, but it depends also on the compass and quality and adjustment of a material organization. It, of course, follows, that if we approach the subject from the physiological side, it is simply impossible to avoid the phraseology of materialism, and therefore, for doing so, I shall make no further apology.

My next postulate is, that the activity of the brain is conditioned by the activity of its circulation. The blood is to the gray matter of the convolutions what atmospheric air is to burning fuel; it is at once a necessity and a stimulus. However favorable may be the arrangement of cell and fiber, the consciousness will fail to respond to any impression, and every cerebral function will be impaired or suspended, if the circulation be lowered below a certain amount.

It follows that, so far as physiological means are to enable us to understand how mind and brain mutually act on one another, a consideration of the laws that affect the distribution of blood, and the influence of local surroundings in modifying these, must be of the first importance. Yet this is what is very seldom attended to. Volumes have been written on the relationship of mind and brain with scarcely a single reference to this aspect of the subject. While considerable progress has been made in defining the immediate sphere of activity, in certain mental acts, and especially in mapping the centers for voluntary motion, very little attention has been given to the influence which the many peculiarities of the encephalic circulation must have on the mode in which the brain may exercise its functions.

The principal general fact in regard to the local distribution of blood on which I have at present to lay stress is that, as a rule, the supply to every tissue and organ is in proportion to the demand for it. When function is quiescent, the need is slight in comparison with that of active exercise, and accordingly we find that the circulation of any organ contrasts remarkably in the two states.

Considerable difference of opinion has existed as to how this is immediately accomplished. By many writers the vaso-motor nerves seem to be regarded as veritable physiological demons, whose unsleeping vigilance foresees and provides for all local wants; and it is supposed that, while the whole motor force acting on the blood is supplied by the heart's action, these nerves so regulate the caliber of the smaller

arteries that they turn on or shut off the blood-current as may seem to be necessary. While not disposed to question their great importance, a good deal might be said in favor of the notion that the molecular agitation in the tissue itself has a direct influence not only in assisting movement by lessening friction, but by exerting positive energy in urging the current onward.*

Into the controversy on these points, however, I can not enter here. For our present purpose it will be sufficient if the intimate relations between demand and supply be admitted as a matter of fact; if we can assume that functional activity involves a fuller volume and more rapid movement of blood in the capillaries of a part than does functional rest.

The last postulate I have to submit is the one on which my subsequent argument must mainly rest; but, unfortunately, it is the one whose soundness is most likely to be questioned. It is, that the mass of blood within the cranial cavity can be neither increased nor diminished directly, nor, indeed, to an appreciable extent within short periods of time.

A general statement of the argument in its support may lie in a nutshell. The available cubic space within the skull being a fixed quantity, the bulk of its contents must also continue uniform. These contents being the brain-tissue, the blood and the cerebro-spinal fluid, no one of these can be altered without an inverse change in one or both of the other contents. Thus, if a degenerative nutrition cause wasting of the brain-tissue, we must have an increase in one or both of the fluid contents, and thus evidence will be got of extreme congestion, or of serous effusion, or both. For any such change, however, time is required. Again, no amount of general depletion can reduce the intra-cranial circulation until time is afforded to allow effusion of serum to occur, because no mechanism exists for immediately raising any fluid from the spinal canal. Neither, on the other hand, can any increased force of the heart's action make the intra-cranial vessels fuller, for the cerebro-spinal fluid can not be immediately dis-

* In recent works on physiology it has been the tendency to ignore, if not altogether to deny, the active influence of local molecular change on the capillary circulation. In the higher animals, however, we have what I would consider crucial evidence in favor of its existence. I allude to the portal circulation. Here we have a large mass of blood returned from the chylopoietic viscera, which, before it can reach the heart, has to traverse the ramifications of the portal system of vessels. It will be at once admitted that considerable force must be required for the purpose. Now, if a *vis a tergo* alone be employed in moving the blood onward, the whole stress so occasioned must in this instance be borne by the mesenteric veins. The backward pressure within these vessels will be as great as what is required to transmit the blood onward to the vena cava. Is it in the least probable that the thin walls of these veins could bear such a strain? I rather think that we have here evidence that, while the general circulation may be sustained by the action of the heart, certain forces acting at the capillaries give indispensable aid in transmitting the blood through the latter.

placed. It can not be pressed into the spinal canal, for the latter cavity is already tensely full.

Referring to the classical essay of Dr. Kelly * for experimental proof of the difficulty of affecting the mass of intra-cranial blood, I content myself here with a single argument, looking at the subject from a common-sense point of view.

Whatever opinion may be held as to the nature of nervous energy, the phraseology used when its discharge is spoken of implies a certain amount of stress in the nerve-center. Thus, "vibration" can not occur without *tension*, and "explosion" implies previous *repression*. A chord will not give a clear tone when it is relaxed; and, if the chamber in which a cartridge is exploded is not perfectly rigid, the effect on the bullet is weakened. If we are at liberty to reason from analogies like these, we must infer that no nerve-center can have its energy economically liberated unless its structure is subjected to a certain amount of stress. Now, stress in a nerve-center means stress in its circulation, and this involves pressure outward and equally in every direction. If the energy is to be liberated with ease, and with exactness as to amount and direction, support to the structures immediately concerned must be as little yielding as possible. But if the cerebro-spinal fluid is at liberty to flow and ebb as readily as some writers assert, this steady support would be absent. The brain in such a case would resemble an instrument with slackened strings, and would refuse to give a clear response to impressions. Sudden or powerful or exact voluntary effort would then be simply impossible. For here, as everywhere, the discharge of pent-up energy will take place in the direction of least resistance. If the displacement of the organ's support occur more readily than the production of the intended result, such as the movement of a limb, the latter will not be successfully accomplished. Some of the energy would be wasted in the form of simple mechanical effect on the surroundings, and the result, whether mental or motor, will be less precise than would otherwise be the case.

The inference, then, is obvious. If time be an essential factor in the production of any change in the bulk of the brain-tissue, or in that of the cerebro-spinal fluid, then for the time being the mass of intra-cranial blood must also remain a stable quantity.

If we are allowed to assume the correctness of our last postulate, two corollaries require to be kept in view in applying it to encephalic physiology. In the first place, no change can take place in the circulation of one portion of the brain without that of some other part being inversely affected. In the abdomen, a determination of blood to one organ need not of necessity involve a diminished supply to the rest of the cavity, but an analogous occurrence within the skull is

* "Transactions of the Medico-Chirurgical Society of Edinburgh," vol. i.

impossible. If the anterior cerebral arteries, for example, have their supply augmented, then to an exactly corresponding extent a lessened amount can be present in the other encephalic vessels.

In the second place, no change can occur in its circulation without a change in the balance of active pressure through the brain. The stress through the whole cranial cavity must, of course, be equalized, from the amount of fluids present, but the displacement of solid particles must occur, and such displacement is not likely to be without physiological significance.

Assuming the approximate soundness of these principles, we have to consider how they may be applied in encephalic physiology. My immediate object will be to show that they must be of essential importance in any study of the correlations of mind and brain.

The first subjective condition or faculty I have to notice on its somatic side is attention. It is unnecessary to enlarge on the psychological importance of this function. It may be said to underlie every other mental faculty. It is the bringing of the consciousness to a focus in some special direction. It is required to convert sensation into that comprehensive grasp of particulars which constitutes perception; without it, meaningless reverie will take the place of coherent thought; nor can we conceive of any act being strictly voluntary apart from its guidance.

To study it in its physiological relation, we may for convenience take the well-known effect of attention in modifying the intensity of sensation. The mental effect produced by an impression on a sensory surface is stronger, and details about the impressing cause are more completely gathered in, when the mind is concentrated on it. On the other hand, if the consciousness is engrossed in some other direction—if absorbed by an interesting occupation or train of thought—the impression which formerly produced so much effect is felt obscurely or not at all. To account for this difference we can not be content with a merely metaphysical explanation. To say that the mind is so constituted that it can not at one and the same moment entertain with equal distinctness dissociated ideas, is only one half of the truth. There must be a cerebral correlative, and some notion as to the nature of this must be got if we are to come nearer the whole truth.

Two factors, at least, may be specified as bearing on this problem. In the first place, when the consciousness is engrossed by an immediate sensation, the sphere of encephalic activity is comparatively restricted. What that sphere may be in any particular instance it is for anatomy and experiment to determine. For receiving the impression, for quickening the consciousness, and for completing its course as a definite perception, the track involved may be wide and branching, but it does not include the whole brain.

In the second place, *the encephalic circulation will be focused in*

*the direction of activity.* The molecular agitation occasions a necessity and an attraction for more blood, and determination of this takes place all the more freely on account of the quiescence of the larger part of the brain. The latter has, as it were, loosened its hold on the circulation, and the impetus toward those parts which have an attraction for it is thus all the stronger. The increased activity of the circulation then reacts on the energies of the tissue, and the mental effect produced is therefore greater.

If, now, we turn the picture, we find the lights and shadows have changed places. Let the mind be intent on solving some problem, or be engaged on some work requiring close attention and nicety of handling, and the impression which formerly so completely took possession of the consciousness may now not in the least be felt. Here, too, physiological conditions are at work. The impression fails, not simply because the consciousness is otherwise engaged, but because the track along which it is to travel is not now in a fit condition for responding to the stimulus. It is out of focus. The momentum of the circulation is now directed toward the centers of ideation and voluntary motion, and this implies a derivation from, and consequent weakening of, functional vigor in the sensory ganglia.

If the above reasoning be legitimate—even approximately so—it becomes a matter of detail to apply the principle in other directions. In speculating on any point in mental physiology, we have something more than the molecular action of the brain itself to consider. The capillary circulation, too, has its laws, and the encephalic circulation its peculiarities, and a certain balance in the latter must be maintained if cerebration is to be healthy and its outcome exact.

In perfectly normal action it is likely that the molecular changes are the dominant factor and keep the circulation under control; but not unfrequently the mass and velocity of the circulating fluid may determine the sphere as well as the character of the activity, and thus have effect on the outcome, whether muscular or mental.

If the cells of one center or class of centers be too readily explosive, they may attract the blood so strongly as to inhibit the function of other parts of the brain by the comparatively anæmic condition these are thus left in. Of this we have an illustration in the phenomena of an epileptic seizure. Here we have the blood determined in such volume to the motor centers that those which are more immediately related to consciousness have not sufficient left to enable them to sustain function with. Some writers seem to insist that during the seizure the whole brain becomes almost bloodless; but it would be as philosophical to expect a water-wheel to revolve violently by its supply of water being cut off as that the energy of the brain can be prodigally expended in defiance of ordinary physiological conditions.

On the other hand, if the attractive power of some center is under the normal, this may allow a determination to other centers to be

excessive, and in this way, again, the action of the whole encephalon may be modified.

The means usually adopted to induce the hypnotic state afford us an illustration of a mode by which this condition may be brought about. In the first place, the attention is so strained in one direction that fatigue of a motor and of a sensory center has been induced. When this has happened, the molecular agitation that accompanies activity of function becomes more difficult. Repose is needed to restore its former fitness for work. The structures immediately involved are reduced to a condition approaching that of sleep, and as a result they have relaxed their hold on the circulation. The forces which sustain its balance are therefore disturbed. The condition of the encephalic circulation may now be considered analogous to that of the atmosphere with a low barometic pressure; it is mobile and disposed to storms. If attracted in one direction, it is determined strongly. Then, the very momentum with which the blood surges in that special direction reacts on and strengthens function. If it be toward an ideational center, some particular idea may so monopolize the consciousness that the judging faculty is almost as completely in abeyance as in ordinary dreaming. Thus, when something bitter is put into the mouth of a hypnotized subject, and he is told it is sweet, the notion of sweetness becomes dominant because the circulation is so strongly focused toward an ideational center that the gustatory center or track can not respond to its natural stimulus. Its function is suspended on account of the failure of a necessary condition.

In regard to volition, we need not here enlarge on the metaphysical subtilties its discussion has given rise to. We have now to do with it as a faculty subject to the tyranny of organic conditions, and our endeavor is, if possible, to catch at least a glimpse of its mechanism.

The will is essentially a prospective faculty. It must have a goal in view, whether a muscular movement, or an effort of memory, or a process of reasoning be required to reach it. Some notion must precede action, and cerebration does its work without revealing to the consciousness anything of the mechanism employed.

Certain of the factors, however, may be specified with some precision. I, of course, must assume we have to do with an educated brain, in which co-ordination has been established among its various parts.

Ideation, then, the initiatory stage of volition, involves, within a limited area, molecular movement with corresponding vascular excitement. The function of that area becomes active, and *radiation of energy must take place in some direction.* Strands for the purpose of conduction branch off in innumerable lines to other centers. What the immediate direction may be will of course depend on the circumstances of the moment and the results of previous association.

In order that the outcome may correspond with the intention, the

impulse itself must be sufficient in intensity; the "points" (in railway phraseology) must be "open," the line must be clear, and the circulation must be so balanced that it is ready to surge in the required direction. The outcome may be defective by the failure of any of these conditions, and an improved adjustment in some needed respect may at once enable a correct result to be got. Thus, a familiar name or word may escape the memory, and for a time every effort may fail to recall it. Then, for example, a more successful focusing of the circulation taking place in the ideational center, the word comes up without apparent effort. From this point of view, "unconscious cerebration" means simply "better adjustment."

If the radiation be toward a motor center, we find in the latter all the conditions favorable for liberating its energy. In the waking state, in the absence of fatigue or disease, the center requires little more than *permission* to do its work. All the potential conditions for discharge are already there. With the stimulus communicated from another center, we have simultaneously molecular agitation and vascular excitement. The latter acts in two ways. In the first place, by derivation, it removes the inhibitory action of other parts of the brain; and in the second place, it further directly stimulates the molecular movement. The immediate result is turgescence or orgasm in the center itself. Then, the general law in physics, that action and reaction are equal and contrary, must here hold good. If the surroundings, therefore, be stable, natural relief will be got by the overflow or discharge of energy into a motor nerve, and contraction of a muscle will be the result. On the other hand, if the support afforded to the center be insufficient, the vascular turgescence will to some extent spend itself in displacing the surrounding tissues, and the intended movement will either not take place, or it will fail in precision and strength.

My object in the present paper has been rather to give prominence to what I consider a neglected factor in cerebral physiology than to attempt its application to all possible instances. I shall be satisfied if I have said enough to show the importance of investigation in the direction I have indicated. Indeed, when one reflects on how much research is devoted to the minute structure of the brain itself, it seems surprising that so little attention is given to what may be called intracranial physics. We have here a field which is at least as likely to be fruitful in results as the attempt to measure and classify all the varieties of nerve-cell, or to unravel the complex network of nerve-fibers.

Within the skull we have an *imperium in imperio*, where, with loyal fealty to the interests and claims of imperial unity, the rights of "home-rule" are jealously conserved. As the speck of protoplasm requires the restraint of the cell-wall to enable it to develop and exercise some specific form of energy, so the brain-mass has its form molded, and its development directed, and, especially, its energies exercised under the severe repression of membrane and bone. Then,

in the approximately—if not for a time absolutely—stable mass of blood in the encephalic vessels as a whole, in the arrangement of the vessels themselves, and in the relation of their contents to the pressure of the atmosphere, we have conditions which contrast so remarkably with those we find in any other part of the body, that a consideration of their significance is surely deserving more attention from physiologists than it has yet received.—*Brain.*

## HOW TO WARM OUR HOUSES.

By E. Y. ROBBINS.

IF a blizzard of unusual severity were coming from the northwest that would send the thermometer down 50° or 70° in three hours, we should expect a great increase of pneumonia and other respiratory diseases, resulting in many deaths. Now, instead of three hours, suppose the mercury were to drop threescore degrees in three *minutes*—or take another step in fancy, and suppose this great change to take place in three *seconds*—what would likely be the effect on health? And yet we bring about, artificially, changes to ourselves quite as sudden and as severe as this.

We make an artificial climate in our houses. We live in-doors in an atmosphere heated by stoves, furnaces, or steam-pipes, to 70° or 80°; and we pass from our parlor or hall so heated into the open air. At a step, literally in a breath, the temperature of the air has, for us, dropped 50° or 70°. We may put on an extra coat or shawl and shield the *outside* of the body and chest, but we can not shield the delicate linings and membranes of the air-passages, the bronchial tubes, the lung-cells. *Naked*, they receive the full force of the change—the last breath at 70°, the next at freezing or zero—and all *unprepared*. We have been sitting, perhaps for hours, in a tropical atmosphere; nay, worse, in an atmosphere deprived by hot iron surfaces of its ozone and natural refreshing and bracing qualities. Our lungs are all relaxed, debilitated, unstrung; and in this condition the cold air strikes them perhaps 60° below what they are graduated to and prepared for. Is it strange if pneumonia and bronchitis are at hand?

If we are in the West Indies, or even in Florida, and wish to come North in winter, we try to make the change gradual. But in our houses we keep up a tropical climate, or worse, for you have not the freshness of air that prevails in an open tropical atmosphere, and we step at once into an atmosphere as much colder as 40° difference of latitude will make it. It is in effect going from Cuba to Iceland—or at least to New York—at a step, and we make the journey perhaps a dozen times a day. And often, while we are still shut up in our domicili-

ary Cuban climate, Iceland comes down upon us from an open window. Especially is this likely to occur in school-houses, where children will instinctively seek to get a breath of fresh air that has not had all its natural refreshing qualities quite cooked out of it by hot stoves, furnaces, or steam-pipes. And all these sudden changes and shocks of cold come upon us while the whole system has its vitality and powers of resistance gauged down to the low necessities of a tropical climate.

And what should we expect as the effect upon the health—upon the respiratory organs? What are the facts? Pneumonia has increased nearly threefold in New York, in proportion to the population, within the last fifty years; and, if we had separate records for that class who most use the hot-air arrangements, we probably would find a much greater increase.

Bronchitis, which is also getting to be a very prevalent and fatal disease, has increased even more rapidly than pneumonia, and now causes about fifteen hundred deaths in New York city every year, being an increase of nearly *fivefold* to the population in fifty years. What is the cause? We have a sufficient and a very obvious cause, in the fact that in our methods of heating our houses we have been "progressing backward." Fifty years ago there were few furnaces or close stoves, and no steam-pipes, for warming; houses were warmed by open fires. The difference is radical and of great importance.

It may be briefly explained thus: Radiant heat from the sun or from an open fire passes through the air (so far as it is *pure air*) without warming it; that is to say, without being obstructed or retained by it (just as light does), and only warms the pavement, floor, walls, or other opaque body on which it falls. Hence, on a sunny day, the pavement will be at 100°, while the air above it is only 50°. The air that touches the iron bars or the surface of the fire in an open grate goes to *feed* the fire, and then is drawn up the chimney. Only pure, radiant heat is thrown into the room, not hot air; and it does not heat the air at all *directly*, but warms our bodies, the walls, furniture, etc.

Recently we have thrown this aside, and, instead, put a surface of hot iron in the room or in the cellar, in the form of stove or furnace, or steam-pipes, or hot-water pipes, against which the air *itself* is heated by convection or contact, and by its consequent lightness rises into the room and to the ceiling.

By the first method—open radiation—we warm our bodies, walls, floor, furniture; by the second we heat the *air*. By the first method all the heat the air gets it gets from floor, walls, and furniture. By the second, all the heat the floor, walls, and furniture get they get from the air, the process being exactly the reverse. The difference is radical and great.

By radiation from sun or open fire we get a quick, active heat,

that travels nearly 200,000 miles in a second. By convection, or hot air from iron surfaces, we have a comparatively dead or dormant heat that moves only a few feet in the same time. By radiation from open fires the air is the coolest thing in the room; by the air-heating method it is the hottest. By open fires the lungs get less heat than any other part of us, and so are braced and strengthened; by the hot-air process they get more heat than any other part, because the hottest air rises uppermost about the head, and so is inhaled, making the lungs tender and sensitive to cold on our going out. Put a thermometer at the floor, and another at the ceiling, in a room heated by the hot-air process, and you will find the air at the ceiling from 15° to 45° warmer than at the floor. And so the head is surrounded by a torrid atmosphere, while the feet may be cold.

We want to warm our bodies, not the air. Cool air is denser, contains more oxygen, and warms the blood more than hot air, besides refreshing and strengthening the lungs, and bracing them against injury on going out. We want air with a normal amount of ozone. We get it with the ozone all destroyed by the hot-iron surfaces. The Professor of Chemistry in the London University (Dr. Graham, a very high authority) says ozone is destroyed at 140°.

Suppose the top of your house removed, and the sun shining freely down into it in winter. Your floor, walls, furniture, and your clothing, will have a temperature of, say, 100°, while the air itself will be only at 50° or 60°. An open fire is a miniature sun, and its radiation is governed by the same laws as that of its great prototype. With an open fire put in proper position in your room, while your walls and floor will be at about 80° or 90°, the air will be at 50°. Replace this open fire by an air-heating arrangement, and your floor and walls will be found to be only 50°, more or less, while the air rises from your close stove or your hot-air register at from 140° to 250°. If you doubt it, put a thermometer in your register, and see.

What do we want of such air as this? Evidently nothing, and so kind Nature sends it upward as quickly as possible, to get it beyond our reach; but we defeat her beneficent intent by closing the ventilators at the ceiling; and so after cooling somewhat it descends, still far too warm (and robbed of all its ozone, and the refreshing qualities of natural air), to enfeeble the lungs, and render them susceptible of injury on going into the external air.

The only remedy for all these mischievous conditions and effects is entirely to abandon the plan of applying the heat to the air—of making the air the carrier of heat. Heat wants no carrier, any more than light. It can outfly Mercury "and the swift-winged couriers of the air." Put your fire in proper position; take away the iron and brick casings that inclose it and obstruct its natural movements, and, quicker than you can think, the heat will be flashed all over your room; darting out in straight lines in every direction from the surface of the

fire—down, up, and horizontally; and this without expense for pipes or hot-air ducts. If one grate is not enough, put another on the opposite side of your room. Coals are cheaper than coffins; and wood is better used to keep the body alive than to inclose it when dead.

An almost perfect arrangement for warming a room would be an open fire, and the entire surface of the walls and ceiling formed of a reflecting material. Then the least possible fire would warm us, because the heat would be kept alive, active, radiant; being reflected constantly from side to side, and up to ceiling and back, as quick as lightning-flashes; and so, impinging upon the body on all sides, would give it a lively, glowing warmth, while the air might be at almost any lower temperature. It would be like having a fire on every side of the room. Of course, this could not, in practice, be *perfectly* carried out, but it might easily be carried out approximately. Common tin plate is said to reflect eighty-eight per cent of the rays of heat that strike it. This might be stamped with some pleasant design, impressing it very slightly, to break up any distorted reflection of images. Possibly wall-paper might be made with a figured metallic reflecting surface. For a school-house this would be a great improvement, as it would reflect the *light* as well as heat from every side, and so prevent distorted positions of sitting, which are often found to prevail where the light is only on one side of the pupils.

With the heat of an open fire radiating or reflected upon our bodies, we should not want so warm an atmosphere by 20° or 30° as we do when all the heat *in the air*. And so the air would be fresh and invigorating, and the lungs would be braced up and strengthened to resist any shock from inhaling the external air. Of course, we must be *comfortable*. We must not suppose that suffering with cold is good for health. But we want just as little warmth of *air* as is consistent with comfort; and we want the heat *free* from the air, and of an active character. As long as we make our school-houses and dwellings hot-houses, or rather hot-air houses, we must expect to see our children grow up hot-air productions, liable to be withered by exposure, and blasted by pneumonia and consumption.

Some places among the high Alps have recently become famous as winter health resorts. Dr. Wise, in a book recently published in London, descriptive of some of these places, says that at Davos, a point in the Alps five thousand feet high, and surrounded by still higher snow-covered mountains, invalids can remain in the open air, even when it is 15° or 20° below the freezing-point, simply by the warmth of solar radiation and the reflection of the sun's rays from the surrounding snow-crystals. He says that the reflection of the sunbeams from the surface of the snow is so strong that ladies who carry parasols over their heads, and so preserve their complexion from the influence of the *direct* rays of the sun, nevertheless become tanned ("burnt" is the word he uses) by the reflected rays from the snow

below and around them.* Altogether it is something like a great room, half a mile wide, with mountain-walls covered with snow, two or three thousand feet high, and floor of snow; open above, with the sun's rays pouring down, and the heat being reflected from every side and from below, by a million million snow-crystals, warming the bodies of the invalids; while the mountain-walls keep off the winds, and the quiet air is perhaps 10° or 20° below freezing.

This is Nature's sanitarium (though the picture may be a little overdrawn above the reality), and such a sanitarium, in miniature, we may have in every house, and in every school and college, if we will, by discarding our present abominable air-heating arrangements, and using, instead, open fires, in proper positions and at proper elevations for obtaining the best results (either with or without reflecting walls), and with ceilings of perforated tin plate, for the double purpose of reflection and ventilation. We want no little, inefficient, pepper-box ventilators, nor an air-supply that will send a perceptible current of cold air upon one side of us. The perforated, metallic ceiling might be stamped with appropriate artistic designs, which the light would bring out and make pleasant to the eye. In public halls this might be beautifully and appropriately carried out by an artist of good taste. In any case the reflecting surface must be made of the proper material, as some substances (a common looking-glass, for instance) reflect light from an open fire, but not the heat, well.

In a large room several grates on different sides would be required, and to obtain the best results they should be set at somewhat different altitude and in different position from the ordinary setting. Indeed, they may be made to give out double the heat they usually give. The front surface of a fire is the main efficient heating surface. Hence the grate should be made several bars higher in front than common, and if it is set higher up in the wall than usual and inclined forward at the top, it will be found to radiate downward and warm the floor much more effectually. But all these improvements in the shape, position, and setting of the grates can be easily come at by a little practice and philosophy. The main thing to be done is to quit the use of debilitating hot air, and warm the body by radiant heat, giving the lungs cool, refreshing, bracing air to breathe. It is a most important matter. Money can not measure the value that such a change in our method of warming houses and schools would be to the nation. We would be healthier and happier, and in the course of generations would have appreciably and measurably more perfect physical forms, more active brains, clearer minds, and better morals—better morals, I say, if for no other reason than that of our obeying the laws of Nature, which are the laws of God.

* See, also, an article by Professor Edward Frankland, entitled "A Great Winter Sanitarium for the American Continent," published in "The Popular Science Monthly" for July, 1885.—EDITOR.

# THE WINGS OF BIRDS.*

By Professor W. H. FLOWER, F. R. S.,
DIRECTOR OF THE BRITISH NATURAL HISTORY MUSEUM.

THE power of flying through the air is one of the principal characteristics of the class of birds. Although some members of the other great divisions of the vertebrates—the bats among mammals, the extinct pterodactyl among reptiles, the flying-fishes among pisces—possess this power in a greater or less degree, these are all exceptional forms, whereas in birds the faculty of flight is the rule, its absence the exception. Among invertebrates this power is possessed in a very complete degree by the greater number of insects.

In the normal structure of the vertebrate animals there are two pairs of limbs, anterior and posterior, never more. It often happens, however, that one pair, and sometimes both, are suppressed, being rudimentary, functionless, or entirely absent. Flight is always performed by the anterior or pectoral pair, more or less modified for the purpose. The superaddition of wings to arms, as in the pictorial representations of angels, has no counterpart in nature. The wings of the bird, the bat, the pterodactyl, and flying-fish, are the homologues of the arms of man, the fore-legs of beasts. In the flying-fish the power is gained simply by an enlargement of the pectoral fin, and the function is very imperfect; in the pterodactyl, by immense elongation of one (the outer) finger, and extension of the skin between it and the side of the body; in the bats, by elongation of the four outer fingers, and extension of a web of skin between them and the body. In the bird the flying organ is constructed mainly of epidermic structures, peculiar outgrowths from the surface, called *feathers*—modifications of the same tissue which constitutes the hair, horns, scales, or nails of other animals. Feathers are met with only in birds, and are found in all the existing members of the class, constituting the general covering of the surface of the body.

The framework to which the broad expanse formed by the feathers is attached is composed of bones, essentially resembling those of the fore-limbs of other vertebrates. The distal segment, manus, or hand, in the vast majority of birds, has three metacarpal bones and digits, the former being more or less united together in the adult state. The digits appear to correspond with the pollex, index, and medius of the typical pentadactyl manus; the second is always the longest. Both it and the pollex frequently bear small horny claws at their extremity, concealed among the feathers and functionless, but very significant in relation to the probable original condition of the avian wing. These

* Abstract of a lecture delivered at the Royal Institution of Great Britain, February 19, 1886.

claws are altogether distinct from the large, and often functional, spurs developed in many species from the edge of the metacarpal bones, resembling both in use and situation the corresponding weapons in the hind-feet. The third digit does not bear a second phalanx or claw in any existing bird.

The quills, remiges, or flight-feathers attached to the bones of the manus (called "primaries"), never exceed twelve in number, and are (as has been recently shown by Mr. Wray) in the very great majority of birds distributed as follows: Six, or in some few cases (flamingo, storks, grebes, etc.) seven, to the metacarpus; of the remainder or digital feathers, one (*ad-digital*) is attached close to the metacarpo-phalangeal articulation, and rests on the phalanx of the third digit; two (*mid-digital*) have their bases attached to the broad dorsal surface of the basal phalanx of the second digit, which is grooved to receive them; the remainder (*præ-digital*) are attached to the second phalanx of the same digit. These last vary greatly in development; in fact, their variations constitute the most important structural differences of the wing. In most birds there are two: the proximal one well developed, the distal always rudimentary; but the former may show every degree of shortening, until it becomes quite rudimentary, or even altogether absent, as in *Fringillidæ* and other "nine-primaried" birds, in which there are six metacarpal remiges, one ad-digital, two mid-digital, and no prædigitals, or only a very rudimentary one. The smaller feathers at the base of the quills, called upper and under coverts, have an equally regular arrangement. The webs or vanes of all the flight-feathers are made up of a series of parallel "barbs" which cohere together by means of minute hooklets, and so present a continuous, solid, resisting surface to the air.

Such is the characteristic structure of the wing in almost all carinate birds, whether powerfully developed for flight, as in the eagles, albatrosses, or swifts, or whether reduced in size and power to practically useless organs, as in the extinct great auk, the dodo and its kindred, weka rail, notornis, cnemiornis, etc., most of which, being inhabitants of islands containing no destructive land mammals, appear to have lost the principal inducement, and with it the power, to fly.

In the penguins (*Speniscomorphæ*) the feathery covering of the wing entirely departs from the normal type. Each feather is like a flattened scale frayed out at the edges, the barbs are non-coherent and have no hooklets. They form an imbricated covering of both surfaces of the wing, including the broad patagium which extends from the cubital side of the limb, but appear to have no definite relation to the bones, and can not be divided into distinct groups, corresponding to those described above. The structure of the wing separates the penguins sharply from all the other carinate birds.

The *Ratitæ*, or birds without keel to the sternum, form another very distinct group, distinguished by the rudimentary or imperfect

condition of the remiges or quills, which never have coherent barbs, and are therefore unfitted to the purpose of flight. In the ostrich and rhea the bones, though comparatively small, are distinct and complete, and the feathers large and definitely arranged. The emu, cassowary, and apteryx show various degrees of degeneration, which apparently culminated in the dinornis, no trace of a wing-bone of which bird has ever been found. The question which naturally presents itself with regard to these birds is, whether they represent a stage through which all have passed before acquiring perfect wings, or whether they are descendants of birds which had once such wings, but which have become degraded by want of use. In the absence of paleontological evidence it is difficult to decide this point. The complete structure of the bony framework of the ostrich's wing, with its two distinct claws, rather points to its direct descent from the reptilian hand, without ever having passed through the stage of a flying organ. The function of locomotion being entirely performed by powerfully developed hind-legs, and the beak, mounted on the long, flexible neck, being sufficient for the offices commonly performed by hands, the fore-limbs appear to have degenerated or disappeared, just as the hind-limbs of the whales disappeared when their locomotory functions were transferred to the tail. This view is strengthened by the great light that has been thrown on the origin of the wings of the flying birds by the fortunate discovery of the *Archæopteryx* of the Solenhofen beds of Jurassic age, as in this most remarkable animal, half lizard and half bird, the process of modification from hand to perfect flying bird is clearly demonstrated. The three digits, which in the existing forms are more or less pressed together and imperfect, still retain their freedom and complete number of phalanges, and are each armed with terminal claws, while the flight-feathers and remiges of the cubital, metacarpal, and digital series are fully developed and evidently functional. The earlier stages in which the outer digits were still present, and the feathers imperfectly formed or merely altered scales, are not yet in evidence.

Some conception of the process by which a wing may have been formed may also be derived from the study of the growth of feathers on the feet of some domestic varieties of pigeons and poultry.

## MEASURING THE EARTH'S SURFACE.

By FRANCESCO SANSONE.

GEODETICAL science—that is, the particular branch of human investigation which is devoted to ascertain what are the exact form and dimensions of the earth—has not been slow to follow the general progress. The advance made in this branch of studies since it was first proved that the earth's form was spheric, and since Galileo

uttered his historical "*Eppur si muove,*" has been parallel to the advance made in all other branches of scientific knowledge and methods of investigation.

The first notions concerning the form of the earth were that its form was that of a tablet, ending abruptly at its extremities into what would be considered the abyss, which could not be reached by man. The idea that the earth was nothing but a plane was abandoned before the beginning of the Christian era. The earlier attempts at calculating the size of the globe were based on astronomical observations. It would be difficult to-day to say within what degree of accuracy the figures then obtained could have been relied upon, as the units of measurement used by those pioneers have been lost and could not be compared with the units now in use.

One of the earlier attempts at obtaining the actual length of the earth's meridian by direct measurement of a portion of the same was made in the sixteenth century by a French doctor. The means employed, although very ingenious, would be considered perfectly clumsy and inadequate by the modern scientist. There was in this early measurement no attempt at mathematical precision as understood in the present century, and, considering the simplicity of the method employed by the doctor, it is only to be wondered that no greater error was obtained in its final result. The measurement consisted simply in driving from Paris to Amiens, and counting the revolutions of the wheels of the carriage, and from the number of revolutions of the wheels obtain the distance between the two cities, which could serve as a basis for calculating the length of the meridian. Of course, this calculation could not by any means be considered accurate, but, taking into account the means employed, the result obtained has been subsequently found to be wonderfully precise. The most curious thing about it is, that what would now be considered grave errors and inexactitudes were so distributed that they almost compensated each other, and the dimensions then obtained show only slight differences with the dimensions given by the most recent measurements. Thus chance (and no better name could be found) permitted of the same results, with only a small final error, being obtained with that crude method, that are now obtained with the most precise instruments and with the most complicated calculations,

Geodetical triangulation is, like many of the other branches of scientific applications, essentially a child of the modern era. It is not older than the seventeenth century; the first application of geodetical triangulation to the measurement of an arc of the earth's meridian having been made in Holland at the beginning of that century. It was followed by similar measurements in England and in France, but in all these measurements the arc measured was never greater than two degrees, and the importance of such measurements on the question of the length of the earth's meridian could therefore not be con-

sidered very great. This fact was so keenly felt that the work done in France was extended both in a southward and in a northward direction at the beginning of the eighteenth century, and the distance between Dunkerque and Perpignan, the northern and southern extremities of France, was obtained by triangulation.

What is geodetical triangulation? If two sides and one angle, or one side and two angles, or three sides of a triangle, are known, the remaining parts of the triangle can be calculated by means of well-known formulas. It is on this property of triangles that geodetical or trigonometrical triangulation is based. Supposing the exact distance between two cities situated from one hundred to five hundred miles from each other has to be measured, it is not necessary to tramp the whole distance with a surveyor's chain or other measuring instrument. Such measurement would be too tedious, besides being incorrect, and could not be made in a straight line, even supposing that the ground between the two cities were all level, and that no obstacles intervened to render such straight-line measurement altogether impossible. But this difficulty can be obviated and the exact distance ascertained by means of triangulation. A number of intermediate points are taken, situated so that each three of them form a triangle in which the angles are not too small to be measured. The two ends of the line whose length has to be calculated are also used as points. A series of triangles is thus obtained, the sides of which are of course imaginary, between the points chosen. These points are called stations. The whole system of stations, and of the imaginary lines between these, is what is known as a triangular or trigonometrical net, because when drawn on paper all the lines between the various stations form a sort of net. If the actual distance between two of the stations of the net is known, and if the angles between any two lines of the net are measured by means of special instruments, all the distances between the various stations can be calculated, and thus the distances between any two stations, whether terminal or intermediate, can be ascertained.

However simple this work may seem in appearance, the difficulties to be encountered in its execution, and the probabilities of errors to be avoided, are so many that special scientific skill and thorough ability and training are required in those who have to undertake the practical execution of the work. Like much other scientific work, it has to be a work of love rather than a matter of duty on the part of the executors on whose observations the accuracy of the result necessarily depends. Dangerous ascents and solitary life on the top of high mountains, with no other society than that of the few assistants who accompany him, are common occurrences for the geodete. Not less dangerous to him is the ignorance and greed of the mountaineers, who, seeing his bright, well-kept instruments, imagine that they are made of gold, and often do not stop at any means to get possession of what they consider will make their fortune.

The progress made by mathematical science during the seventeenth and eighteenth centuries, and the great controversy raging then concerning the exact form of the earth, resulted in a serious attempt being made to measure arcs of the meridian at different places on the surface of the globe, and as much as possible near the central parallel, the equator, and the extreme parallel that could be reached, the polar circle. This work was undertaken by the French Academy of Sciences, and two expeditions were fitted out to undertake such measurements, one in Sweden and the other in Peru. The execution of the work was very accurate, considering the difficulties under which it was undertaken. Their purpose was to obtain the exact length of a degree at those different latitudes, and from these lengths the exact form of the earth. The results of the work done by the two expeditions were made known about the year 1750, and showed that the length of a degree near the equator was shorter than that of a degree in a northern latitude, the difference, expressed roughly and in a popular manner, being a little less than one per cent. This confirmed the theory which had been previously proposed, that the earth was depressed near the pole, so that, although this theory had been already advanced before the end of the seventeenth century, it was not generally accepted until it was shown to be correct by actual measurement. The impetus given to geodetical measurements by the last-named expeditions and by the results obtained was so great that geodetical work began to be done in earnest. The English triangulation was begun before the close of the last century. In India a short arc measurement was also executed about the same time.

The outbreak of the French Revolution, and the new ideas which it gave rise to, were the direct cause of the most interesting scientific work done at the close of the last century. As they abolished the privileges of classes, the new ideas tended also to abolish the privileges of systems, and a new system of computation was tried to be introduced which would give uniformity in division. This division was the decimal instead of duodecimal or others which had been until then the prevailing ones. Thus the year was divided into twelve months, and the month into three weeks of ten days each, the tenth day being made a civil holiday; the remaining five days of the year not being distributed in the various months, as with the Gregorian Calendar, but being put together as a civic yearly period of festivity at the end of the year, which was made to begin with the September moon, on the twenty-second day of September. The same was done as regards the system and units of measurement, value, etc.; but, while the time-divisions were made on a rather arbitrary basis, and have, therefore, not been able to supersede the older and more natural divisions, the decimal system of measures, weights, and values which was then introduced, rested on a thoroughly scientific basis, and has therefore been able to withstand all attacks and to gain introduction into the

larger number of states into which Europe is divided. This system is the metric system.

Aside from the fact that the metric or decimal system permits of all sorts of calculations being made more quickly and easily, it possesses as its foundation a basis which is thoroughly scientific. The other systems of measurement are based on a more or less arbitrary standard, which may be indestructible, but which is liable to alter like anything made by the hands of mortal. But the basis on which the metric system rests can be supposed to be unalterable, being the earth itself as measured by the length of its meridian. The standard of unit in the metric system is the metre, the length of which is the $\frac{1}{10000000}$ part of the quadrant, or the $\frac{1}{40000000}$ part of the whole meridian. In order, therefore, to obtain the exact length of the metre, it was necessary to measure an arc of meridian of sufficient length to guarantee the exact calculation of the whole meridian. This arc, which had a length of nearly ten degrees, was measured between Dunkerque and Barcelona, the most prominent mathematicians of the time in France being intrusted with the execution. Although the greatest possible accuracy obtainable at that time was secured, the method of execution was not so perfect as those now in use. The metallic thermometer, invented by Borda, and which is described further on in the base measurement, was then used for the first time, but, instead of iron and zinc, the metals used were platinum and copper.

This arc was later on extended from Barcelona southward as far as the Balearic Isles by Arago and other French observers, who ran their net southward through Spain, and measured some very large triangles between the continent and the islands.

In all European countries geodetical measurements were made during the first half of the present century. To combine all these different lines measured by uniting them by means of special chains of triangles, and so obtain series of uninterrupted observations over a comparatively large area, was the work undertaken by Bessel in Prussia. This work possesses a high scientific and historical value on account of the thoroughness with which it was executed, and because the methods of execution then applied have become standard and have been accepted and imitated in modern geodesy. The geographical position of Prussia rendered the triangulation there of special importance as a means of connection between the different lines measured in the countries north and south, east and west of Prussia. This work was begun in 1831, and a connection was made between the French and Russian triangulations, and between the Danish and the South German nets.

Continental Europe has always taken the first place as the home of science; and scientific work, of whatever kind, can not fail to be duly appreciated there and to obtain that encouragement it necessarily needs. But Europe is politically so divided that the various states, however populous and powerful, are comparatively small in extent. For the

accurate solution of geodetical problems vast areas and long distances are necessary, and these none of the European countries possess except Russia with its Asiatic dependencies. It has therefore been found necessary, in the interest of science, that the various countries combine together so as to have reliable observations extending over a vast area of territory which could be put together and aid in the solution of the problem that most interests the modern geodete—the exact form and size of the earth.

Although one by one the triangulations of each continental country were connected with those of the countries immediately surrounding it, there was no uniformity in the whole work until the proposal was made that all the countries combine together and act on a uniform scientific plan.

In the United States no geodetical work was done before the year 1831. The only arc measurement executed previous to that date was made by Mason and Dixon in the eighteenth century. It is a part of the line now separating the States of Maryland and Delaware, the direction of which is almost exactly north to south. The length of the arc was not over one and one half degree, and was measured directly with long wooden rods.

More recently the United States Coast and Geodetic Survey have been actively engaged in completing the measurement of an arc north to south and another east to west, the work done so far on the first bringing its length to twenty-two degrees, while the parallel arc across the continent will have when completed a length of forty-nine degrees. The advantages which these measurements in the United States have as scientific results are their great length, and, being executed by one authority, their uniformity in the methods of execution.

Although the principle is always the same, the methods of execution in geodetical work may show slight variations from one country to another. The following description of the field-work that has to be done is therefore of a general character, being intended to give the reader who is not familiar with mathematical studies, and with methods of measurement, an insight into the thoroughness with which geodetical work has to be executed, and the minuteness with which all the details of the work have to be carefully considered.

If the length of one side of a triangle is known, the length of the other two sides can be calculated, provided that at least two of the angles of the triangle can be measured by direct or indirect observation. It is therefore indispensable that a straight line be carefully measured, and the length of this line can be used as a basis by means of which all the distances between the various points or stations of the net can be calculated. This straight line that is actually measured in the field is used as the side of one of the triangles, and the other two sides are calculated with the help of the angles which can be measured by means of angular observations. The two sides of the first triangle, the lengths

of which have been calculated, form with other imaginary lines other triangles, which may be designated as triangles numbers 2, 3, 4, etc. Each triangle has one side in common with the following triangle. Triangle number 1, for instance, may have one side in common with number 2, and one with number 3. If, therefore, the lengths of the three sides of triangle number 1 are known, these, together with the observations of the angles of number 2 and number 3, permit of the lengths of the sides of triangles number 2 and number 3 to be calculated, and so on.

The straight line that has to be actually measured in the field is known as a geodetical base. The accuracy necessary in the measurement of a geodetical base leaves all ordinary methods of which surveyors dispose altogether out of the question as too incorrect; a system of measurement has therefore to be applied which permits of the measurement being executed in a line scrupulously straight, of all variations in temperature which can affect the length of the measuring-rods being carefully noted and kept account of, and of the rods themselves being kept in a perfectly horizontal position. The measuring-rods are themselves very delicate and costly instruments. They consist of a prism of iron or steel, four metres long, on the upper surface of which another rod of metallic zinc rests, the zinc rod being somewhat shorter than the other, both being so placed on their supports as to prevent their bending and allowing them free expansion. The coefficient of expansion of zinc is much greater than that of iron, therefore the expansion or contraction of the zinc rod is much greater than that of the other. Changes in temperature in the two metals can thus be easily ascertained by actual measurement of the distance which separates the end of the zinc rod from a given point, marked on the iron rod. Four or six such rods are used for measuring a geodetical base. The rods are each in a long, wooden case, provided with micrometric arrangements for placing the rods in a straight line, raising or lowering the ends so as to have them perfectly horizontal; with spirit-levels, glasses, microscopes, etc. When the rods have been carefully placed in line, the distance between the end of one rod and the following has to be ascertained, and also, for getting at the actual length of each rod, the difference in the length of the iron and zinc rod in each of the cases. A small space is always left between two rods, which are not made to touch each other, in order to avoid sudden and too sharp contact. This intervening space, as well as the varying distance between the ends of the zinc and iron rods, is measured by means of small pieces of crystal a few inches long which have the form of half-prisms, being larger at one end and growing gradually smaller toward the other end. In fact, two of the four sides lengthwise have the form of a trapeze, while the other two are rectangles. One of these rectangular faces is divided to scale, and the observer has only to insert this piece of crystal between the two ends of the rods, without forcing it in, and to call the scale.

The same is done for noting the variation in temperature by measuring the space between the ends of the iron and zinc rods in each case. In order to leave no cause for error, the two ends of each rod are cut to sharp edges and made one vertical and the other horizontal, and the horizontal end of one rod faces the vertical end of the other. The same is done for the zinc and iron. When one of the cases is moved forward and placed in position ahead of the others, all the measurements between any two rods are repeated in order to detect whether any of the other rods has moved while the other was being placed in position. Spirit-levels are on each case, and their variation is carefully measured with microscopes. All the data are registered, and have afterward to be carefully gone over, and all compensations for error, temperature, etc., duly allowed. This apparatus is known as Bessel's base-measuring apparatus, the chief feature of which is the metallic thermometer with iron and zinc.

The length of a geodetical base varies according to the area to be covered by the net and to the possibility of finding a good ground for laying such a base. From five to ten miles would be considered a good geodetical base, one longer than the higher figure not being advisable on account of the possible increase in the inevitable error of such measurement. Even bases of about two miles have been measured, but these could not be used for very large triangulations, and are more intended as a check on other measurement and as a means of compensating errors. The ground has to be carefully leveled before the base can be measured. The two end-points of the base are marked by stone monuments which can be seen at a distance, and the whole length is divided into so many sections, each of which constitutes a day's work, stone and metallic tablets being laid and the line marked in advance before the actual measurement can be undertaken.

It is not necessary that the base should be actually measured before the real triangulation work—that is, the measuring of the angles at each of the stations of the net—is begun. The work of measuring a base is necessarily very slow. All apparatuses have to be carefully tested before being actually used in the field. Each of the rods has to be subjected to a series of experiments at different temperatures, in order to determine the actual expansion of the iron by comparison with that of the zinc. The actual measuring in the field occupies one or two months' time, and may be longer if the weather is not favorable, the whole distance, divided into sections, each of which constitutes a day's work, being measured at least twice, once in each sense. Five or six experienced operators are required, besides a number of assistants to do the menial work—such as carrying the rods forward, etc. The calculations are, later on, done in the office, and are in themselves a very slow and exhaustive process. Taking all together, the time required is little short of one year, including the preparatory experiments and the calculations.

When the base-line has been established and measured, and its terminals have been so marked with permanent material as to be practically indestructible, the base has to be developed—that is, a complete set of observations has to be made for the purpose of connecting the base with the stations of the net. The base being, as a rule, much shorter than the sides of the triangles of the actual net, it can not be connected directly with these large sides, as the triangles thus formed would have very small angles. A special net of triangles, the sides of which grow larger by degrees until they reach the large sides of the actual net, is established. This small net is given the form of a polygon for the purpose of increasing the accuracy. Longer bases are sometimes divided into two halves, and, besides the two terminals, a central station is established in the middle of the base, and thus three base stations are obtained instead of two. All the angular observations at the base stations, and at those which may be called stations of development, are made in the same number and with the same accuracy as in those of the net proper. They are all considered as first-class stations.

All geodetical points at which angular observations are made can be divided into four classes. In the first class are included all the base stations, the developing stations, and the actual stations of the geodetical net. The second class includes those stations which are of secondary importance geodetically, and which do not belong to the net proper. The observations at these stations are not so exhaustive as in first-class stations, although they are used also for controlling the observations of the others. Third- and fourth-class stations have more importance as topographical points, as they are used by the topographical operators as starting-points when mapping out the country. For scientific purposes, only the data collected at first-class stations are used, all others being rejected.

For ordinary topographical purposes, the number of angular observations at each station is not so large as when these have to be used for scientific purposes.

Except for the measurement of bases, geodetical triangulation consists almost exclusively in angular observations. In fact, it can be called essentially a measurement by angles, the work to be done, and on which many years may be spent before even a small net can be called complete, being an uninterrupted series of measurements of angles. Very delicate instruments are used in these measurements. The best part of an observer's outfit consists of a good theodolite. Although simple in principle, the theodolite is a very complicated instrument, and a good deal of practice is necessary to enable an observer to become efficient in handling this delicate machine. It consists chiefly in a good field-glass, which can be turned in every direction, so as to enable the observer to see the exact spots in the distance which are the stations of the net, and of a circle on which a scale, carefully divided, enables the observer to read the angle between

any two directions in which the glass may be pointed. The glass may be turned toward any point on the horizon, and also in an upward or downward direction. The scale on the circle is read by means of two microscopes, diametrically opposite to each other. Spirit-levels, micrometric arrangements, etc., are provided, and the observer has to be very careful about placing his instrument in the right position before he can actually begin operations. Although the stations are not at the same altitude, the angles between any two directions have to be so measured as if the stations were all on the same level, on a perfect plane. This plane is supposed to be vertical to the earth's radius which crosses that particular station—that is, a plane tangent to the earth's circumference and perfectly horizontal. The movement of the field-glass has, therefore, to be such that, although two stations may be situated lower or higher, the angle between the two directions can be read as if each of them had been raised or lowered vertically to the level of the station from which the observations are being made. The circle of the theodolite represents this horizontal plane ; its center is supposed to be mathematically "the point," and the theodolite has, therefore, to be so placed that the center of this circle is in a perfect perpendicular to the point, while the surface of the circle itself is perfectly horizontal. The field-glass is situated on a support in the form of a double column, and the central axis of this support is vertical to the circle, and passes through its center. Delicate and exact mechanical arrangements permit of the glass being turned toward all points of the compass, and also of its being turned in an upward or downward direction ; but each movement is either in a horizontal or a vertical direction to the circle. This enables the observer to obtain the angle desired—that is, the angle which any two directions would give if all the stations were at the same level.

The length of the sides of the triangles varies according to the facilities for extending a good net which the ground offers. From twelve miles upward is a suitable distance, the distance being in some cases only limited by the visual power of the glass.

The scale on the circle is divided into degrees, minutes, and possibly seconds, the latter and their fractions being read with the microscope.

The angles are measured as follows : When the theodolite is placed in its exact position, and the circle is perfectly horizontal, the glass is pointed successively at each of the surrounding stations, and for every direction the scale on the circle is read and noted on the field-book. Supposing the scale reads 56° 18′ 12·075″ when the glass is pointed toward one station, and 115° 56′ 18·850″ when pointed in another direction, the angle between the two directions is equal to the difference between the two readings, which is in this case 59° 38′ 6·775″. These readings are repeated several times, the circle being every time moved around its center in order not to have all the readings on the same divisions of the scale. When a complete set of observations has been

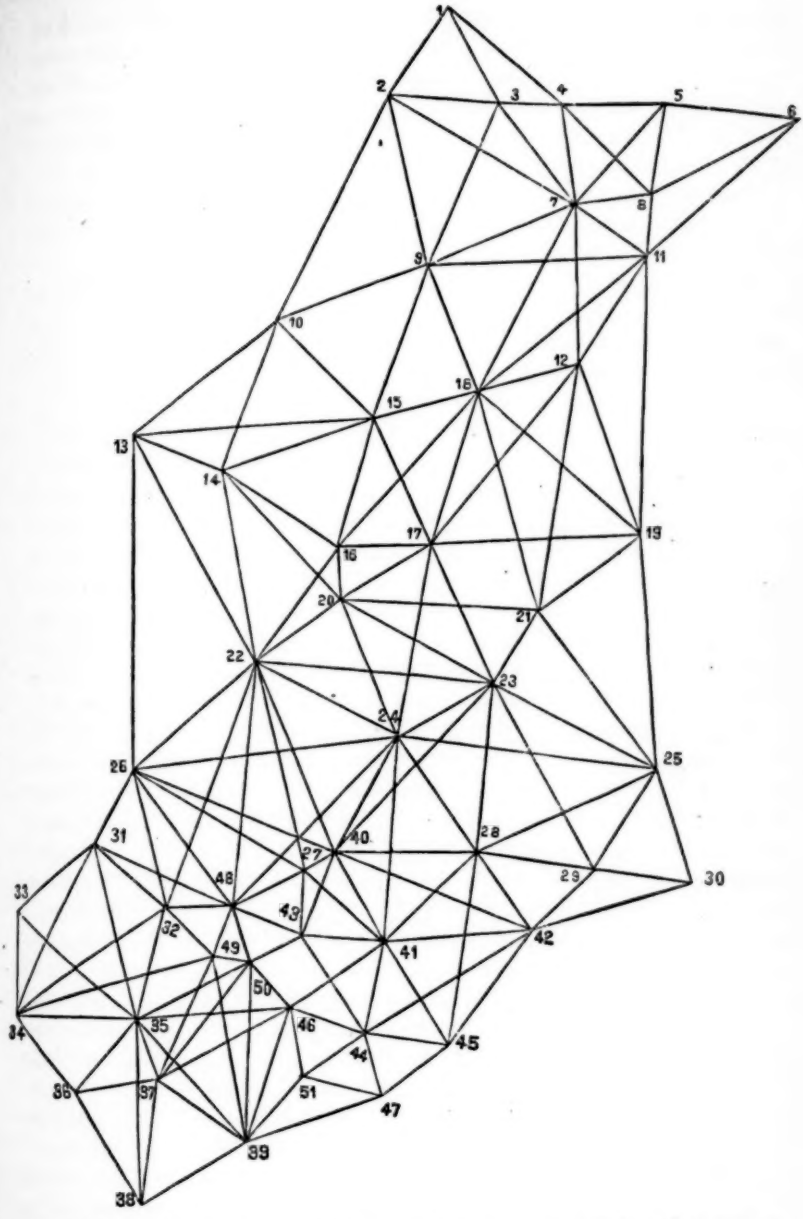
made, another set of observations is begun with the field-glass inverted. The observer places the larger end of the glass toward him, and turns the glass upside down around the axis, so that by this movement the smaller end of the glass comes to stay near the observer. With the glass thus inverted observations are repeated. The moving around of the circle and inverting of the glass are intended to avoid any errors which might be caused by faulty construction of the instrument, as, however costly and delicate the instrument may be, human skill can not make it mathematically precise.

When the angles have been measured, all the calculations have to be made for each triangle and for each polygon separately. Neither the work of mensuration in the field nor the calculations are what would be called work done by steam or by electricity. The season for the field observations being necessarily limited, each observer can not cover more than two or three first-class stations each year, as much as two months being often spent for one station alone when the climatic conditions are unfavorable. Angular observations for scientific purposes can not be executed in all weathers and at all hours.

Geodetical triangulation can be more successfully executed in mountainous regions, where the peaks act as natural observatories, and nothing interferes to prevent distant points being seen with the glass. Before the measuring of the angles actually begins, the net has to be laid out, the stations have to be visited, the most suitable point to be chosen and marked with some permanent sign. Stone blocks are used for this purpose, in the center of which a square metallic tablet is laid. The intersection of the two diagonals of the metallic tablet is the geodetical point. A small pyramid is sometimes placed in lieu of the tablet. In order to see the exact spot at a distance, a pyramid of wood or other material is built over the same, and a metallic rod, similar to a lightning-rod, situated in an exact perpendicular to the "point," is placed on top of the pyramid. This rod acts for all practical purposes as the real spot when the observer is at a distance. For stations situated in the plains, church-steeples, towers, or the tops of high buildings are used, and a given spot on these is chosen as the geodetical point, care being taken to choose only such points as are likely to be permanent for future reference, and are not liable to get out of the perpendicular.

The carefully executed observations described in the foregoing have to be made so accurate in order to avoid errors, which, although they may be allowed up to a certain limit when a topographical survey is alone being made, can not be allowed when the triangulation has to be made use of for purposes of getting at the real dimensions of the globe. An error which may be neglected on an area of a few hundred square miles is not permissible, and would be too large if multiplied to the whole length of the earth's meridian.

The accompanying illustration will serve to show what is a geodetical or trigonometrical net of triangles. It is not an imaginary net, but




one which has been actually laid out and measured. This net is a part of the work done by the United States Geodetic Survey, and is that portion of it which covers the whole State of New Jersey. It is copied from reports kindly furnished by Mr. G. H. Cook, State Geologist of New Jersey. It includes all the stations in New Jersey, and a few in

the surrounding States, in all forty-seven stations. They are all first-class stations. To show how slow geodetical triangulation has necessarily to be, it may be stated that in the small State of New Jersey alone this work has been going on for nearly thirteen years, and is now nearly completed, only a few stations remaining to be covered at the beginning of the year 1886.

I may here state also that a few of the historical facts I have given are taken from "Elements of Geodesy," by J. Howard Gore, B. S., just published.

The idea of connecting the various measurements in the different European states was later on improved upon, and for the purpose of obtaining good, reliable data, collected on a system of uniformity sufficiently numerous and covering a large area of territory, all the states of Continental Europe have combined in the interest of science. If each country did its work separately, and the data obtained in one could not be compared with others, the observations made would have only a local value, and, being limited in extent, could not have that scientific weight which it is necessary they should have. All European countries have felt the necessity of having thorough topographical surveys made, so as to possess good, detailed maps of their territory. This work being considered necessary for military purposes, its execution has been undertaken by the military authorities. The triangulation work necessary for this purpose could, with little addition, be extended so as to connect the geodetical nets of the various countries and form a complete system of nets extending over the whole continent. An agreement was entered into, by the various states into which Europe is divided, that the geodetic data which were being collected and the observations that were being made should become common property, and that all the observations being made on a standard of uniformity agreed upon by all parties concerned, they should be used in common for the purpose of furthering the scientific problem and obtaining a series of nets, by means of which the exact distance between any two points on the European Continent could be easily calculated.

The common work—that is, the direction of the whole as an international undertaking, each country doing its own share within its own borders—has been confided to an international commission specially founded for the purpose, and which is known as the Commission Internationale pour la Mesure du Degré en Europe. All the states are represented in this commission, the representatives being mostly the heads of the geodetical department of each country, and some of the best-known astronomers. The best specialists of Europe, who have devoted their life to this branch of studies, belong to this commission.

The international agreement makes it possible to have uninterrupted chains of triangles across the whole continent, from north to south, and from east to west. It is, however, not necessary that the

nets should extend over the whole area of each country. Neither the topographical necessities nor the scientific requirements make such a complete geodetical survey indispensable. Those countries possessing a comparatively larger territory would find a complete triangulation too costly and too slow. Each country has therefore laid its nets as it thought best. The Atlantic countries, France and Spain, have laid a series of parallel nets from north to south, and another from east to west, crossing each other almost at right angles. Supposing each of these nets to be drawn on the map, but instead of the various triangles a thick black line to be laid down as a sort of central line of each separate net, the whole systems would have the appearance of square grates or pigeon-holes. Germany and Austria have not observed the same rule; their lines are less regular in form, although just as convenient for the purpose. Italy and the smaller states have found it necessary to cover their whole territory, on account of their irregular geographical form, or their smallness. Sweden and Norway have run several nets, and also Russia; but the vast area to be covered leaves a thorough and systematic triangulation of the whole country out of the question.

The control which observations extending over such a vast area permit is very great. The possibilities of its being extended over a still wider field are only limited by political difficulties and by the great cost necessary for its execution in half-civilized countries. The result of the work undertaken by the International Commission can not fail to be of the highest scientific value, and the standing of the men who compose it is a guarantee that the greatest efficiency and thoroughness characterize the work done.

Of the calculations necessary, and which follow the field-work, the least said the better. To an outsider, one who is incapable of comprehending the scientific purpose of the same, they look very much like time wasted and which could have been better employed. It will suffice to say that all calculations are made twice and independently of each other. Each set of calculators do their work independently of the other, and only compare the final result. Months and months elapse before a partial result is reached, and before other and more complicated calculations can be begun. But the battle-field is one worthy of man; he has arrayed himself against figures, and, although slowly, he conquers them with the help of formulas, equations, and logarithms, all children of his fertile brain. The scientific result is obtained with scientific means. From beginning to end, geodetical triangulation is purely scientific; nothing is left to chance, and, although it can not by any means be mathematically precise, it comes as near the point of complete correctness as it is possible for any human thing to be.

## SULLY'S HAND-BOOK OF PSYCHOLOGY.*

By CARVETH READ.

THE "Outlines of Psychology" was written, as the title-page showed, "with special reference to the theory of education." Sometimes in the midst of the text, but chiefly at the end of each chapter, abundant remarks and reflections were introduced, showing the bearing of the principles of mental science upon the training of faculty and character in the young. The work has been (as it deserved to be) very acceptable to the public—especially to students—and it would be a great mistake to suppose that the present "Hand-book" is intended to, or possibly can, supersede it. But it has been felt that the "Outlines," in spite of its modest title, is too long and detailed, and sometimes perhaps too abstruse and difficult, for many parents and teachers, who would gladly see their task in the light of science, but either have not much time to spare, or else lack the special training that is requisite for the more intricate questions of psychology. For them, accordingly, the present smaller volume has been produced.

The "Hand-book" begins with a discussion of the scope of education and of its relation to psychology. After this preliminary chapter the book is based upon and follows generally the course of the "Outlines," giving a succinct but luminous view of the best scientific doctrine with regard to the senses, perception, the higher intellectual powers, the emotions, and volition. But the applications of the science to the problems of education are no longer, as in the larger work, separated from the exposition of the science itself by any difference of type or arrangement. Doctrine and precept are fused into a continuous whole, which, assisted by an openly printed page and an effective style, becomes, I must say, extremely readable, considering the nature of the subject. Upon each branch of the subject enough is said concerning the principles of psychology to serve the ordinary purposes of the educator; and everything is said so simply that no one, however unaccustomed to such inquiries, can fail to follow and understand it. There is no attempt to enter into subtile disquisitions or vexed controversies. The bog-fires of metaphysic, hardly seen to glimmer on the borders of the demesne, can tempt no wayfarer to go astray. Every sentence is subordinated to the single end of clearing up the problem how best to train the minds and characters of the young. And the inferences drawn step by step as the book advances, and the suggestions made upon this most important of all subjects, are an admirable example of the application of science to life. Who can help wishing

* The Teacher's Hand-Book of Psychology. On the Basis of the "Outlines of Psychology." New York: D. Appleton & Co. 1886.

to have been born later, and to share the more enlightened instruction that awaits the next generation?

If I were to take exception to anything in the scientific aspect of this book, it would be chiefly to the treatment of conception, judgment, and reasoning, which seems to me too much under the influence of ordinary logic. But even here what seems to me questionable lies more in the expression than in the thought; and there is, after all, in this part of the exposition some advantage in availing one's self of the terms and distinctions of logic; since many readers will partly understand them to begin with, and will thereby be more readily familiarized with the abstruser ideas of psychology. Still, this advantage may be bought too dear. In the practical aspect of the book, I am inclined to say that it lays too much stress upon the importance of authority in moral training. But probably few of those for whom the book is intended will think the author's doctrine of discipline overstrict. His treatment of the emotions and sentiments in relation to education, a particularly difficult and important part of the work, seems to me especially good.

It is a striking fact, the sudden turning of so many first-rate minds to the subject of education; and a great revolution in scholastic affairs, however gradual, will certainly result from it. No subject ought to be so universally interesting. If none seem so tedious to us, it may be because our own education was so bad; or that we have reflected so little about it that new suggestions find in our minds no soil to strike root in; or that the complexity and practical difficulties of it paralyze our faculties: in any case, the more reason for spurring ourselves to the study. There is no subject more beset with popular errors, none in which science is more useful, explanatory, and suggestive. Not only every professional educator, but every father and mother (amateur educators!), ought to have some acquaintance with psychology. However absurd this seems, I defend it on the ground that nothing else enables one to interpret the faint and fragmentary recollections of having been one's self a child: without which how can other children be known, and, if unknown, how trained? At school I often used to wonder whether the masters had ever been to school, they knew so little of what we boys were thinking, feeling, and about to do. I have heard an educated woman say of her baby, squalling of course at six months old, "I believe he knows he's doing wrong." Heautomorphism, in default of science, is ever the first resource of explanation; i. e., we judge of others by ourselves. Discipline without knowledge, and therefore without sympathy, an outside wooden machinery, hampering and crushing, is the same in schools, in homes, and in prisons.

Science is certainly useful; yet it may be perverted by an ingenious mind. It has been urged that, according to the theory of evolution, education must with each generation become less necessary: I suppose, because the amount of inherited faculty grows greater. But

this inheritance is only potential: its realization depends partly on education; and the more of it there is, the more education is requisite. The truth which the above opinion has mistaken is, that the power of education is limited both for good and evil by the nature of a child. But this truth the world did not wait for the theory of evolution to reveal. The notion that character and understanding depend wholly on the experience and training of the individual was never adopted by common sense. It is everywhere recognized that no education, however good, can insure against taking one of the by-paths of the Pilgrim's Progress that man who has some deep ancestral taint—"a bad avidge" one calls it in Cornwall (however that word should be spelled). On the other hand, the first rule for a successful educator is to get a good pupil. But this does not conflict with the further truth that the greater natural potency of development which accompanies civilization, makes the teacher's task not less necessary, but (as far as it goes) more exacting, requiring greater care and skill; since, first, the subject to be trained becomes more complex and delicate; secondly, the time during which it requires supervision increases; thirdly, the changes occurring in it during that time are more numerous and less predictable; and, lastly (not to seek further reasons), the world to which it is to be adapted grows far more complex and exigent. How rapidly the world has changed in the last three hundred years, and how little scholastic education has tried to keep pace with it! So much the more desirable is it that the changes now inevitable should be made in the light of scientific criticism.

To the scientific criticism of education Mr. Sully brings every requisite. A wide reputation as a psychologist guarantees the competence of his theoretical knowledge. A deep and varied culture in science, literature, and art enables him to survey the whole field of labor. He has for a long time studied education as a science, and in so doing has availed himself of all the work of his predecessors and contemporaries both at home and abroad. Whoever wishes to make an exhaustive study of the subject will find in the appendices to his chapters a sort of index to educational literature. Mr. Sully has, moreover, direct experience of the difficulties of education both in its earliest and most advanced stages. Many of the anecdotes that enliven his book bear the stamp of personal observation. And a humane and serious spirit everywhere dispenses wisdom as well as knowledge.

In this "Hand-book" education is, of course, treated in a broad and general way, covering both the early years of training at home and the later periods at school. But there would be manifest advantages in treating these ages and conditions separately with more specific detail. Again, while a work of this sort begins with psychological principles and then proceeds to apply them to education, teachers might be more readily interested by the method of beginning with the particular problems and difficulties of their art, and then exhibiting

the principles involved in them; or of beginning with the rules of education that have been empirically collected and handed down, and then testing and evaluating these by scientific analysis. One great difficulty of education is how to deal with the various classes into which pupils fall as to their powers and groups of powers. The same treatment can not be good for all alike; but how to adapt it to each? We want an ethology of the school-room, somewhat more discriminative than that ethology of the assembly that Aristotle gives in his "Rhetoric." After that would come the question, What studies and combinations were suited to each type? But the field of suggestion is wide and the labor therein light.—*Mind.*

## SKETCH OF M. ARAGO.

ON the 26th of February last the one-hundredth anniversary of the birth of François Arago was celebrated at Perpignan, France, his native city. A grand celebration of the day had also been planned at Paris, to be held under the direction of the scientific men and publicists of the capital, but the municipal subvention, on which its promoters depended for its expenses, was not granted, and it failed. Nearly seven years previous to this time, on the 21st of September, 1879, a statue of the philosopher and patriot, the work of M. Mercier, was inaugurated at Perpignan; and one year previous to it an eloquent eulogy on M. Arago was delivered in the Academy of Sciences by M. Jules Jamin.

DOMINIQUE FRANÇOIS ARAGO was born at Estagel, near Perpignan, February 26, 1786. His father, who was a sub-treasurer at Perpignan, put him to school quite early in the college of that city. At seventeen years of age he was admitted to the Polytechnic School after a brilliant examination, in which he exhibited a peculiar spirit of independence, rising to the point of chiding his examiner for unwillingness to question him on account of his delicate appearance. Some months afterward, when the proclamation of the empire was contemplated, circulars inviting the act were distributed and introduced into the school to be signed by the pupils. Arago refused to sign the paper, and was the leader among the pupils who took that position. General Lacuée, reporting the transaction to the first consul, demanded that the recusants be dismissed from the school. Bonaparte took the list, read it, and remarked: "We will only not send the first name up for promotion. We shall have to give these boys a little time to be converted. You others have turned too quickly."

Before the end of his course at the Polytechnic, Arago, whose abilities had impressed all of his teachers, was appointed a secretary in the *Bureau des Longitudes*, where he became associated with Biot,

twelve years his senior, who was destined to be his co-worker or rival, according to circumstances, during his life. In 1806 he and Biot were appointed by the emperor to co-operate with the Spanish commissioners, Chaix and Rodriguez, in continuing the measurement of the arc of the meridian, for the establishment of the metric system. In this expedition he found arduous work, and underwent hard sufferings from the fortunes of war, the story of which we will let M. Jamin tell further along. He returned to France in the summer of 1809, and was received into the Academy of Sciences, in departure from its rules, at the age of twenty-three years. The emperor, who always manifested a remarkable esteem for him, considering how he had behaved when a school-boy, appointed him Professor of Analysis and Geodesy in the Polytechnic School, a position, or the equivalent of which, he held for twenty years. He also became director of the observatory and delivered lectures on astronomy, which were heard with equal interest by astronomers and by persons who knew nothing of mathematics, and were fully understood by the latter.

In 1830 he took the place of Fourier as perpetual secretary of the Academy, in which position it became his duty to pronounce eulogies upon deceased members, the felicity of the style and the scientific accuracy of which gained for him a world-wide reputation.

In 1830 M. Arago became a member of the Chamber of Deputies for the *Pyrénées-Orientales*. He took his seat on the Extreme Left, and became a conspicuous advocate of measures tending to the extension of public liberty and to electoral reform. He was also prominent in discussions relating to the marine canals, public instruction, and railroads. When the revolution that expelled the Orleans dynasty took place in 1848, M. Arago was made a member of the provisional government by popular acclamation, and was given charge of the bureaus of the marine and of war. He took part in all the events of that stirring epoch, sat among the moderate members, opposed the most radical republicans, while he always enjoyed their respect, was a member of the executive commission appointed by the Constituent Assembly, and marched to the barricades at the head of his troops during the bloody days of June. But so many struggles and shocks had broken his physical and moral energies, and he afterward sat in the Legislative Assembly without taking an active part. He declined to take the oath to the new government in 1852, as inconsistent with his past acts and professions, and was excused from it, and was allowed to keep his place in the observatory unsworn. He died in the next year, October 2, 1853.

The scientific, personal, and social aspects of Arago's life have been admirably portrayed by M. Jamin in his eulogy, and most of what follows on those points is drawn from that address. The first scientific labors coming under his notice were in association with Biot, the continuation of Borda's investigations of the indices of refraction

of gases, and the determination of the relative densities of the air and mercury, from which they were able to calculate theoretically the constant of the barometric formula. The two friends next were interested in the scheme of continuing the measurement of the arc of the meridian from the shore-line at Barcelona, where Delambre and Méchain had left it, to Majorca, and thence to Formentera. In the execution of this enterprise it became necessary to set up a beacon-light in the Island of Iviça, and to observe it from two points in Spain, forty leagues off. Arago established himself upon a rock called *Desierto de las Palmas*, the summit of which hardly afforded room enough for his tent and instruments. On account of the distance, the frequency of fogs, and uncertainty as to the exact direction, it was six months before he could get sight of the beacon. As soon as the measurements were made, Biot took the first results to France, leaving his colleague to finish the work at Majorca and Formentera. Then began for Arago a series of exciting adventures. War had been declared with Spain in 1808, and the Majorcans sought to arrest him as a spy. He had barely time to disguise himself, and, gathering up the papers containing his observations and his instruments, to take refuge on the vessel which had brought him to the island. Thence he escaped, with the aid of the ship-captain, to the citadel of Belver, where he passed several months, substantially a prisoner, in making his calculations. He was at last permitted to go to Algiers, where he embarked on a vessel of the regency under the name of a Hungarian merchant, with a false passport, along with a crowd of Mussulmans and renegades, to which were added two lions and a family of monkeys which the dey was sending to his ally the Emperor of France. The vessel was taken close upon Marseilles by a Spanish corsair, "which conducted its prize to Palamos and took Arago to a country where he was only too well known and from which he had nothing good to expect." He suffered great privations till the dey was informed of the state of affairs, and bullied Spain into setting the lions, monkeys, ships, and philosopher again on the way to Marseilles. They had reached that port when a mistral suddenly arose and sent the vessel to the coast of Sardinia, and thence to Bongie, in Algeria, where the new dey, not so friendly as his predecessor, was disposed to hold Arago as a prisoner. Finally, he was allowed to return to France, running a new danger from pursuit by an English cruiser, and at length to receive a welcome from his mother, "who thanked God for having preserved his life, after having had masses said for the repose of his soul; he returned with the triple consecration of having encountered danger, done his duty, and attained a scientific success beyond his anticipations."

In 1809 the phenomena of optics engaged especial attention, and Arago entered upon the study with the ardor of his nature and his age. He engaged in the investigation of the polarization of light, which no one had as yet been able to explain, but of which he reached

a satisfactory and correct elucidation by the aid of the undulatory theory of light. At the time Arago approached this question, only a few of the facts bearing upon the undulatory theory had been determined, while the most of them were unknown, or hardly suspected. He had to begin by finding them out and classifying them, and so bringing himself gradually nearer to the primary ideas. "The work resembled the play of guessing at words, which all the company know but the person who has to find the word. The inquirer has to ply Nature with methodical questions, numerous and close, to extract her secret from her. No one was better suited to the performance of such a part than Arago; no one more obedient to experiment, no one more systematically rebellious to preconceived theories. He began by studying how natural matter becomes polarized, and found that it is when it is divided into two parts. If there is polarized light in one of these parts, an exactly equal quantity of it will be found in the other, both vibrating in perpendicular planes. This mode of division forms a physical law which is still known as Arago's law." From this law Arago drew two practical results. The first one is applicable to lakes and seas, the surface of which divides the light rays into two parts—the reflected part, which takes the color of the sky and vibrates horizontally; and a part which, having penetrated to the interior and having vertical vibrations, is returned to us with the color of the water. "Both parts are mingled, but a double-refracting crystal separates them, and we see in one of the images the reflected sky, and in the other the bottom of the lake and all that it contains." The second result is that the sun, reflecting only natural or unpolarized light, is a flame, an incandescent gas, and not an incandescent solid.

Arago next published his discovery of the phenomena of rotatory polarization, with the production of complementary colors, varying in properties according to the crystalline medium through which they are viewed. One of his experiments was applied to the edification of the public by the optician Soleil, who devised various fanciful designs on laminæ of gypsum, which, colorless in natural light, were transformed, under the working of the polariscope, into polychrome images having the most beautiful appearance. One of the favorite designs was the word "ARAGO" surrounded by a laurel-wreath.

"Rarely," says M. Jamin, "has an inventor ever reached the limits of his discovery. He looks for its consequences where they are not, he goes astray in the labyrinth where no thread guides him, he passes by the truth without perceiving it, and leaves to his successors to reap where he has sown. Like so many others before him, Arago left the great work he had labored at without completing it. He was endowed with unequaled clairvoyance, and divined discoveries before making them; but he had no patience for details: he opened mines without working them out, and began labors without pursuing them. His

first curiosity once satisfied, he gave himself up to new curiosities. He resembled a traveler who glances over a virgin country, gives it a name, and hastens on to more distant horizons. All phenomena excited his imagination without holding him long. An experimenter by inspiration, a discoverer by instinct, he had too much passion, too little leisure, too fertile a spirit, but not enough of that obstinate perseverance that finishes what is begun. . . . Of theoretical ideas which include a whole science in a few general hypotheses, and leave an ineffaceable trace, he produced none, but sometimes repelled them, even when his own experiments led others to them." Biot, his former collaborator, took up Arago's experiments and worked them out in detail to the discovery of those more particular properties of polarization and the two rotatory powers which have been found of such useful application in the arts.

But neither Arago nor Biot was destined to work out the undulatory theory of light in all its significance and to the full explanation of the phenomena. That part fell to the young engineer Fresnel, who, rusticating in a village near Caen, in expiation of some political errors, passed his time in studying optics. He wrote to Arago, and received in return advice by which he profited so well that he shortly afterward published his memoir on diffraction. He and Arago then together made the experiments on interference, by which a theoretical explanation of polarization was obtained; but Arago, heartily with him at the beginning, was not able to follow him in all his conclusions, and left to Fresnel the honor of explaining the experiments which he had himself performed.

Oersted having discovered the power of the voltaic current to produce deviation of the magnet, and having thence deduced the theory of the relationship of magnetism and electricity, Arago took up his experiments. With a conductor of copper wire and a pile of iron filings, he learned that the current would also generate magnetism. He communicated his discovery to Ampère, and they made, with knitting-needles, those experiments in electro-magnetism which transformed a whole science, and cleared the way for the electric telegraphs, electric lights, electric clocks, and other instruments of to-day. One day an artisan of the engineers brought him a compass, which was nearly inert in its copper box, but lively enough in action when taken out of it. Experimenting with this apparatus to discover the cause of the compass's inaction, he discovered the magnetism of rotation—a discovery which Faraday complemented by showing how induction-currents are created in the copper.

The observation of a beautiful aurora borealis in 1817 gave Arago opportunity to verify the fact, which had already been observed and remarked upon, that the bands of light and the arch bore a relation to the magnetic meridian; to this he added the new observation that the magnetic needle was disturbed during the whole time of the preva-

lence of the phenomenon. On consulting the registers of previous observations, he discovered that similar perturbations had accompanied the aurora, even in places where it could not be seen on account of the weather, in the daytime, and in the polar regions. He recollected also that electricity is propagated in vague lights in vacuum-tubes and that these lights are deflected by the magnet; and he affirmed that auroras are electric sparks circulating in the higher parts of the atmosphere, oriented on the terrestrial magnet, and acting on the magnetic needle. This theory was attacked by Brewster, but Arago replied to his argument at length and convincingly.

The experiments which were entered upon for the purpose of measuring the force of the vapor of water were very important and very dangerous: important, because the safe working of steam-engines was dependent upon correct measurements of the force, and because all the properties of heat had to be passed in review; and dangerous, because they "imposed the task of confronting the unknown caprices of a formidable force. There were but two men to accept it and conduct it to success: Arago, who never shrank from a duty; and Dulong, already maimed by an explosion, whose previous studies had admirably prepared him for the new work." A rude manometer was extemporized, and a boiler, far less stanch than the steam-boilers of to-day, was set up, in which water was heated till the pressure was twenty-seven atmospheres. "They could not go further. At this extreme point, it leaked at all the joints, and the steam escaped through the fissures with a hissing that was of bad omen. But the observers, though aware of the danger, silent and resigned, finished without accident the measurements which they had begun." Telling M. Jamin the story, which was written out as above from his dictation, Arago said: "Only one being of our company preserved his serenity and slept quietly; it was Dulong's dog; they called him Omicron."

By the terms of the creation of the *Bureau des Longitudes*, the duties of the direction of the observatory and of delivering the lectures on astronomy were to be performed by the members in turn, a year at a time. Practically they fell continuously to Arago, and from 1813 to 1847 he delivered those lectures on popular astronomy which had a wonderful success, and of the life and vigor of which the tame rendering in the book of that name gives no idea. He did not write them out, but only prepared the outlines, and for the rest depended on the inspiration of the moment. They were attended by young men who went to learn, older men for the pleasure of hearing, and women, M. Jamin suggests, for the pleasure of seeing. "It was his habit, when he rose to speak, to select the least intelligent-looking face in the audience. He then never left it, but seemed to speak for it alone, and continued his demonstration, with various modes, till that face showed that its owner understood him; *a fortiori*, all of the auditory must have understood him as well.

Arago published, in the "Annuaire" of the *Bureau des Longitudes*, popular papers on natural phenomena and on the applications of science to industry. One of these dissertations was on thunder and thunderbolts. Another, which appeared in 1829, was on the history of the steam-engine; others were on rain, the cold of night, the ruddy moon, and the influence of the moon on terrestrial phenomena. He also published a paper on eclipses of the sun; and a total eclipse occurring in July, 1842, which could be favorably seen at Perpignan, he went there to observe it. Notice had already been taken of the aureole which appears around the moon during an eclipse, and to what are now known as the protuberances, and he gave his special attention to them.

Having been made perpetual secretary of the Academy of Sciences in 1830, he was accustomed to come early to the meeting every Monday, where he received foreign *savants*, read the correspondence, and, if it was his day, began the sitting with an analysis of the papers offered; and so clear and so much sought for were his analyses, that the memoirs sent up were frequently indorsed "For M. Arago's day." He also accompanied his analyses with a history of the questions discussed and a criticism of the proposed solution, the authority of which was never contested. In a short time this audience, though evidently illustrious, seemed to him too restricted. He desired to extend it. He had found a close Academy, working without witnesses, with doors closed or only half opened to a few privileged persons. He had them opened wide to all the world; and, in order that science might be spread more rapidly and further, he invited journalists to attend the meetings, and provided a place for them where they could take notes. He further, in 1835, induced the Academy itself to publish its proceedings under the supervision of the perpetual secretaries; and this was the origin of the famous "Comptes Rendus."

As a deputy and member of the political body, Arago proposed a scheme for damming one of the arms of the Seine and establishing a system of turbine pumps by which Paris should be fully supplied with water, which was defeated by a ridiculous jest. He induced the municipal council to bore the Artesian well of Grenelle, which was a great wonder in its day. He secured a public recompense for Vicat, who had invented an economical hydraulic cement. And when Daguerre came forward with his wonderful invention, which made it possible to take an exact portrait, by the aid of the sun, in fifteen minutes, Arago explained the method before the Academy and expounded its capabilities.

While a member of the Legislative Assembly, Arago was attacked with a malady which resulted in a gradual loss of sight, that became total in 1852. Being unable to make further researches, he endeavored to gather up and reduce to form the unfinished work of his past career. The visible results of this effort were seven conferences which

he delivered in the Academy on photometry and polarization, and which were collated by Langier and published with his works. A final experiment, which was made under his direction a short time before his death, was to determine the relative velocity of light through the air and through water. Upon it was thought to hang one of the crucial arguments as between the corpuscular and undulatory theories. The result—determining that light moves more swiftly through the air—was in harmony with the undulatory theory.

Arago's contributions to scientific literature are to be found scattered as special papers recording his experiments, or brief treatises, in the "Memoirs of the Academy of Sciences," the "Mémoires de la Société d'Arcueil," the "Annales de Physique et de Chimie," the "Annuaire du Bureau des Longitudes," where his "Scientific Notices" appeared, and in the reports of his lectures of the observatory, which are embodied in the "Popular Astronomy." They were never arranged by him, but were collected after his death, and published in 1856–'57, in fourteen volumes, of which the "Popular Astronomy" forms the principal part. His chief work in science was in making special investigations, resulting often in brilliant discoveries, which served as the foundation and support of accepted theories. Besides this, he possessed a rare gift, which his friends and biographers claim to be an equal and a specific title of glory, of making scientific truths and conceptions comprehensible to the multitude, and this without sacrificing the dignity of science. He was a member of all the learned societies of Europe, and the particular friend of many foreign scientific men.

The best part of Arago's time was given, according to M. Jamin, to the duties of his professorship in the Polytechnic School. "In this often exacting position, he did not cease to be the object of affection for his good heart, and of admiration for the vigor of his teaching, the ease of his elocution, and the lucidity of his demonstrations. A former pupil himself, he loved his young comrades. It might be affirmed that he was an example to them by his thorough uprightness, judicial-mindedness, disinterestedness, and patriotism, qualities which he communicated, and which became as it were permanent characteristics of that admirable school. He defended it on every occasion, extolled it and looked at everything in its light. Whoever had come out from it was sure of kindness from him. On occasions of difficulty, when a general excitement threatened the discipline and future of the school, the pupils would go to the observatory for advice and protection, and were sure of getting them. He excited like admiration and found like esteem at the observatory." His weakness was, that he was subject to transitory fits of passion, which passed away and left no lasting trace.

# EDITOR'S TABLE.

### THE LESSON OF WIGGINS.

DO not let us put Wiggins away until we have learned all he has to teach us. He may not know much of meteorology or astronomy; he may be ignorant of the very elements of those sciences and of all science; but, it does not follow that he is not a great teacher in his way. The fact is, that the value of Wiggins consists precisely in his ignorance and general lack of sense; seeing that it is owing to these qualities, combined with a large dose of the most shameless assurance, that he is able to preach to us so eloquently regarding the condition of mind of a considerable portion of the community. There is no doubt that the Northern "Professor" has been taken seriously by thousands of honest people. The interest felt in his predictions was measured and reflected by the publicity given to them in the newspaper press. They penetrated into every town and hamlet in the country; and it was no doubt a true remark that somebody made the other day, that for one person who knew the name of the real astronomer, Proctor, ten knew that of the sham astronomer, Wiggins. If simple notoriety was the man's object, he has gained it to an extent which must have exceeded his fondest expectations. The only drawback to his fame is, that it is not so great by any means among his Canadian countrymen as it is with us. Like so many other prophets, his greatest honor has been achieved abroad.

A most remarkable fact in connection with the case is, that the credit of Mr. Wiggins should have survived the most signal and crushing falsification of his former efforts in the prophetic line. It will be within the recollection of some of our readers that he was to have brought on a storm and tidal wave of altogether unparalleled violence and extent some time in the month of March, 1884. He formally notified President Arthur of the impending calamity, which was chiefly to affect the North Atlantic coast of this continent; though there was also to be a tidal wave of unprecedented destructiveness in the Bay of Bengal. The men of real science were prompt in their repudiation of his predictions; they showed that his proposed storm was scheduled to take a course that no storm had ever taken before, and that, in the nature of things, no storm could take; but the fishermen of Maine and Massachusetts thought more of Wiggins than they did of the real representatives of science, and the consequence was that the fishing industry that year suffered not a little. All that came of these dire vaticinations was an ordinary equinoctial gale and a high tide (provided for in the almanac), that did a little harm here and there, but nothing of any account. The tidal wave ordered for the Bay of Bengal refused to put in even the most perfunctory appearance.

Yet, in spite of this, and of the most glaring demonstrations, at the time, of his ignorance, "Professor" Wiggins, who, as we understand, holds some minor clerkship in the Treasury Department at Ottawa, is able to come forward again this year, smiling and confident, with a brand-new set of predictions of the most sensational and preposterous kind. And people hear him—multitudes, at least—gladly. They like to think that the recognized authorities in science have not got things entirely their own way, and that their cautious and exact methods are not the only ones available for arriving at results. They

welcome Wiggins because he aims not to instruct, but to excite and terrify—because he undertakes to tell them things about which other men are silent. The medical quack promises everything; the meteorological and astronomical quack threatens everything; and both achieve popularity. Human nature likes strong sensations.

Once more Wiggins has been put to shame, or put to what any other man would regard as shame; but what guarantee have we that he will not, after the lapse of a few months, don his prophetic robes again and fill the land with the noise of his foolish babblings? None: the probability is that we have not heard the last of Mr. Wiggins by a great deal. It will show a moderation on his part on which we have no reason to count, if he withdraws altogether from the notice of a public that is abundantly willing to forget his past blunders, on the sole condition of his propounding new terrors in complete disregard of all the principles of science.

What we see and lament to see in this whole business is, the evidence afforded of the very slight extent to which true scientific knowledge has as yet permeated the public mind. Large portions of our population are at the mercy of charlatans of every profession and of every type. Some of these prey upon their pockets, some upon their health, some upon their emotions. There is knowledge in the world that ought to be the heritage of all, but that really is confined to a few. The masses have no means of distinguishing between the man who speaks in the name of acquired and organized science and the man who uses a scientific terminology, that he himself only half understands, for the purpose of getting himself talked about. Their sympathies, however, rather go out toward the latter, for the simple reason that, instead of making his statements in guarded language, and building upon the previously ascertained facts of science, he throws all reserve to the winds, and speaks out of the fullness of his ignorance in a tone of the most absolute authority.

It seems trite to say that what is wanted is the more general diffusion of sound scientific knowledge; and yet, with the vast agencies that are now being employed in popular education, it should not be impossible, one would think, to do something to guard the community at large against ridiculous and hurtful delusions such as those which "Professor" Wiggins, with the aid of the press, has been instrumental in creating. We do not see why, in our public schools, some effective instruction might not be given in the spirit and methods of science. It might be shown how the early ages of scientific inquiry were marked by the predominance of the most extravagant fancies and ambitions; and that these had their use in stimulating to researches that would not else have been undertaken. Had the stars not been supposed to control human destinies, they would not have been made the object of so attentive a study in the ancient world. Had men not conceived the possibility of transmuting the baser metals into gold, the rise of the science of chemistry would probably have been long postponed. But to-day the true guide in scientific investigation is scientific analogy. The edifice of universal knowledge is being built up little by little through the contributions of patient students everywhere. To but few is it given to discover the operation of any widely acting law; and these are more prone to announce their discoveries in a modest, tentative fashion—as did Darwin when he published his "Origin of Species"—than to burst forth upon the world with loud and confident assertions.

It might also be shown how widespread and well-organized are the agencies now established for the study of physical phenomena, how many earnest men, equipped with all the knowledge of the age in so far as the sciences

of meteorology and astronomy are concerned, are bending their attention upon the as yet unsolved problems of terrestrial physics; and how very unlikely it is that any great laws should elude their keenest research and most vigilant observation, and yet reveal themselves to an individual of absolutely no scientific standing, and, so far as any one can judge, a mere sensation-monger. A sketch of the history of science, of the order in which its leading discoveries have been made, and of its present resources for the further prosecution of truth, could, we doubt not, be rendered interesting to boys and girls of average school age. The sketch would have to be boldly drawn, in few and simple and striking lines; but this might be done without any sacrifice of accuracy. In this way respect for science as science would be created; and the rising generation would be made not only to feel that it is a power in the world, but to understand what kind of a power it is, and what kind of men its ministers ought to be. The lesson would have moral implications, for the methods of science are simply the best methods of every-day life, methods of patience, of perseverance, of honesty, of reason. To know science as an embodied power, as a personality, so to speak, would be to know that which one would necessarily be the better for knowing, and to be furnished with an ideal of life which, if not complete at all points, would embrace very much that is essential to integrity of intellectual and moral character. Thus, too, would public opinion be steadied and the credulity that is still the reproach of our civilization be reduced within much narrower limits. If Mr. Wiggins should, without intending it, be the means of so drawing attention to our educational deficiencies on the scientific side as to lead to vigorous efforts at reform and improvement, we shall be able hereafter to recall his name with feelings of less unmitigated scorn than would otherwise certainly be his due.

# LITERARY NOTICES.

LETTERS AND JOURNAL OF W. STANLEY JEVONS. Edited by his Wife. London and New York: Macmillan & Co. Pp. 473. Price, $4.

IT is a most enjoyable treat to get a clear insight into the personality of a man who has made himself in any way distinguished, and to realize how like he, whom we have had to regard at a distance and as a kind of abstraction of the cause he is associated with, is to other men, and how fully he is in sympathy with all that is human. The enjoyableness is complete if the man's life has been happy and free from reproach. Such is the case with Professor Jevons as he presents himself in his letters and journal, in which his wife, supplying only such connecting links as were necessary, has wisely decided to give an account of his life in his own words as much as possible. They present him as a man of ordinary susceptibilities, with no extravagant or particularly marked tendencies in any direction, heartily enjoying his family life and his friends, fond of his baths, relishing active sports, entering enthusiastically into the volunteering movement which absorbed English attention while the world was waiting upon Louis Napoleon's nod, showing the musical as his strongest æsthetical taste, and patiently and persistently pursuing the work with which he gave life to the driest statistics and made the most abstruse social and economical facts luminous. The letters are full of good points, and show throughout the keen observer of men, facts, and events, of which the writer says but little, but that little going to the heart of the matter. After a residence of five years in Australia, Mr. Jevons visited the United States in 1859, two years before the beginning of the war. At Washington he "scrambled over the Capitol, the Washington Monument, the Smithsonian Institution, Lafayette Square, with Mr. Sickles's residence," and saw nothing more of the least interest in the American capital. New York he found a great but not very amusing city, while he admired the extreme convenience of the American hotels. Pittsburg was an intolerably smoky manufacturing town, and the great American towns generally were described as "mere collections of great warehouses, shops, wharves,

and handsome dwelling-houses—in fact, merchants' offices and merchants' houses. The alpha and omega of the whole is trade." Mr. Jevons, as is well known, met an untimely death by what was called drowning while bathing in the sea at Galley Hall, near Hastings. His death is ascribed in this book to the shock of the cold water, which was no doubt too severe for his enfeebled health, and produced such an effect upon the weak action of his heart as to cause syncope and render him, after the first plunge, quite unconscious and powerless to help himself. The Rev. Robert Harley said of him, in the Royal Society, that he "was a man as remarkable for modesty of character and generous appreciation of the labors of others as for unwearied industry, devotion to work of the highest and purest kind, and thorough independence and originality of thought. The bequest which he has left to the world is not represented solely by the results of his intellectual toil, widely as these are appreciated, not only in England but also in America and on the Continent of Europe. A pure and lofty character is more precious than any achievements in the field of knowledge; and though its influences are not easy to trace, it is often more powerful in the inspiration which it breathes than the literary or scientific productions of the man." The editor of the "Spectator" said that he had other qualities than those of the philosophical thinker, "not always found in men of science, which make his character as unique as his intellect. At once shy and genial, and full of the appreciation of the humor of human life, eager as he was in his solitary studies, he enjoyed nothing so much as to find himself thawing in the lively companionship of his friends. Something of a recluse in temperament, his generous and tender nature rebelled against the seclusion into which his studies and his not unfrequent dyspepsia drove him. His hearty laugh was something unique in itself, and made every one the happier who heard it. His humble estimate of himself and his doubts of his power of inspiring affection, or even strong friendship, were singularly remarkable, when contrasted with the great courage which he had of his opinions; nevertheless, his dependence on human ties for his happiness was as complete as the love he felt for his chosen friends was strong and faithful. Moreover, there was a deep religious feeling at the bottom of his nature, which made the materialistic tone of the day as alien to him as all true science, whether on material, or on intellectual, or on spiritual themes, was unaffectedly dear to him." A bibliography of Mr. Jevons's writings, by the year and month, is given at the end of the volume.

THE ORIGIN OF REPUBLICAN FORM OF GOVERNMENT IN THE UNITED STATES. By OSCAR S. STRAUS. New York: G. P. Putnam's Sons. 1885. Pp. 149. Price, $1.

THIS treatise is an enlargement of a lecture which attracted much favorable attention when delivered first in New York, and subsequently before the Long Island Historical Society in Brooklyn. The author's purpose is to examine into the reasons why the republican form of government was originally selected by the people of the American colonies upon their separation from the mother country, in preference to every other form of polity. He ascribes such selection "mainly to ecclesiastical causes which operated from the time the Pilgrims set foot upon our continent, and to the direct and indirect influence of the Hebrew commonwealth."

Mr. Straus makes out a much stronger case for his hypothesis than might at first be supposed. He has industriously collected a good deal of pertinent historical matter tending to exhibit the religious causes of the American Revolution, to indicate the controlling Biblical ideas which influenced in one way and another the minds of the founders of the republic, and to prove how potent those ideas really were in molding the scheme of the new government. He has also traced out and made very evident some striking analogies between the United States government as finally constituted, and the Hebrew state under the judges. He considers, indeed, that the Hebrew commonwealth was the first well-developed democratic republic. This is seen in the divisions of general governmental functions, in the preservation of the tribal governments in federation under a national administration, in the recognition of civil equality, in the elective franchise, and in the separation of church and state—which last is a fact

usually overlooked by students of Hebrew history.

Altogether the book is an exceedingly interesting and useful study; and the thought presented strikes out a fruitful and an unusual line of comparison. The author is never dogmatic, but his spirit is always that of the careful student and the scientific inquirer. As a literary production the work is admirable; the style is clear, the diction elegant and finished, and the reader's interest is well sustained to the end.

PARALYSES, CEREBRAL, BULBAR, AND SPINAL. A Manual of Diagnosis for Students and Practitioners. By H. CHARLTON BASTIAN. New York: D. Appleton & Co. Pp. 671. Price, $4.50.

THIS treatise is intended as an aid to the student or medical practitioner when brought face to face with cases of paralysis of different kinds. Instead of setting forth in the fullest manner all that is known of the several forms of the disease, as may be done in special treatises, the author's endeavor has been throughout to facilitate diagnosis; to explain and gather up the essential points to be borne in mind by the student or practitioner when he is called upon to decide as to the nature of any case of paralysis, and give a prognosis concerning it. The various forms of paralysis are now so numerous, and so many advances have been made in our knowledge in the directions of their origins, that some such aid to diagnosis may well be looked for by those for whom this work is intended. The signs of paralysis of the different cranial nerves have been pretty freely dealt with, because the recognition of such paralysis, either alone or in association with paralysis in other parts, is often a matter of the greatest importance. As a knowledge of nervous diseases of the kind now looked for can not be attained without something more than a superficial acquaintance with the anatomy and physiology of the spinal cord, a plenitude of details, especially of anatomical details, is necessary in such a treatise as the present one is intended to be. The comprehension and recollection of these details have been facilitated, as far as possible, by illustrations. The threefold division of the subject suggested in the title is followed in the text; and, to the sections there indicated, another is added on paralysis due to lesions of the cranial nerves. The general course of the discussion of the subject is outlined in a few pages of introduction. Paralyses of encephalic origin are then taken up, with reference, first, to the several conditions that cause them, and next to the diagnosis, or the clinical considerations favoring the existence of this or that causative condition. The pathological diagnosis is considered as applied, in the apoplectic stage, to primary and secondary comas, and again after or in the absence of an apoplectic stage. Under the head of regional diagnosis are discussed the regional or localizing value of special symptoms that may be associated with the paralysis, and the clinical indications favoring the diagnosis as referred to lesions in parts supplied by the cortical and the basal arterial systems, and by the vertebral and basilar arteries, respectively. In the sections on paralyses of bulbar origin, the regional diagnosis is treated with reference to the diagnostic indications derivable from a consideration of the blood-supply of the bulb. Paralyses due to lesions of the cranial nerves are described with reference to the particular nerves involved. The pathological diagnosis of paralyses of spinal origin is described with reference to extrinsic causes and intrinsic causes. In the last hundred pages, full and particular accounts are given of the spinal diseases associated with paralysis, together with tabular exhibits of the diseases and of their relative acuteness or chronicity.

THE BUTTERFLIES OF THE EASTERN UNITED STATES. By G. H. FRENCH. Philadelphia: J. B. Lippincott Company. Pp. 402. Price, $2.

BY "Eastern United States" is meant, for the purposes of this manual, all east of the western boundaries of Minnesota, Iowa, Missouri, Arkansas, and Louisiana; and the region differs from the Atlantic province of Dr. Packard by the variance between State lines and a more sinuous line of elevation, and by the inclusion of the whole of Florida and the New England States and the exclusion of all of Canada. The book appears to have grown up in connection with the author's class-work in the Southern Illinois Normal University. It embraces a brief

description of the several stages of butterflies and of methods of capture and preservation, an analytical key, and a more complete description of all the species that have been found in the region included. The introductory chapter describing the general characteristic and life of butterflies and methods of capturing and treating them is followed by an accentuated list of the butterflies of the Eastern United States, and this by the particular descriptions of genera and species. In the last part, the "preparatory stages," being often essential to a proper understanding of the relations that species bear to one another, and adding much to the interest of the study, are given so far as they are known.

THE INDUSTRIAL SITUATION AND THE QUESTION OF WAGES. By J. SCHOENHOF. New York and London: G. P. Putnam's Sons. 1885. Pp. 157. Price, $1.

IN the papers comprising this volume, Mr. Schoenhof has made a valuable contribution to current tariff discussion, in combating the wide-spread belief that high wages necessitate a high labor-cost in production, and therefore debar a country paying them from competing with a country in which wages are lower. Protectionists have worked assiduously to instill into the minds of the laboring classes the belief that the high rate of wages prevailing in this country is directly dependent upon the tariff, and that, once this prop gone, the laborer must sink to the condition of his European brother. And they have been so far successful that protection has been steadily able to hold its sway in spite of its manifest absurdities and the warring of conflicting interests.

Mr. Schoenhof points out the very obvious fact that it is only the cost of the labor entering into an article which has any bearing upon successful competition in the market. Now, the labor-cost not only may be low along with high wages, but, as a matter of fact, it generally is lowest where the wages are highest. This apparently anomalous state of things is due to the greater perfection of machinery and the greater skill and energy of the workmen in countries paying the higher wages. England, with considerably higher wages than is paid upon the Continent, is yet able to undersell its competitors there; and the United States is able to produce at a lower labor-cost than England. Here machinery has reached its greatest perfection, and the workman has acquired the highest degree of skill and capacity for turning out a large amount of work. The advantages which should accrue to this country from this state of things are, however, neutralized by the taxes upon the materials of production. With free raw materials, Mr. Schoenhof maintains that this country can compete successfully in the markets of the world with any other, and that it is manifestly to the interest of the working-man that we should have as extensive a market as possible. This is the guarantee to him of continuous employment, which is the essential thing for him. He has nothing to fear from a competition with the "pauper labor" of Europe, as already his labor embodied in the product is less than that of this same "pauper labor" in the competing goods of low-wage countries.

The thing the American workman has most to fear is the limitation of the market for his productions, and this is just what protection is securing for him. In support of this general position, Mr. Schoenhof reviews the two staple manufacturing trades, those of metals and textile fabrics, and produces convincing evidence of the correctness of his view. The author writes clearly and to the point, and his reasonings and facts should have the attention alike of the manufacturer and his employé, who are both injured by the protection they persist in believing is for their good.

ARCHITECTURE, HEATING, AND VENTILATION OF INSTITUTIONS FOR THE BLIND. By J. F. MCELROY. Adrian, Mich.: "Times and Expositor." Pp. 21.

THE author is Superintendent of the Michigan School for the Blind, and this pamphlet contains his address before the last meeting of the American Association of Instructors for the Blind. The first point in the architecture of the institution is, that the building should be constructed primarily with reference to its internal requirements, to which the exterior should be only the dress. The internal arrangement should look to spacious and convenient accommodation, free ventilation, proper heating, healthfulness, and the suppression of disturbing noises.

SELECTIONS FOR WRITTEN REPRODUCTION. Designed as an Aid to Composition Writing and Language Study. By EDWARD R. SHAW. New York: D. Appleton & Co. Pp. 102. Price, 75 cents.

EXPLAINING the theory of his book, the compiler says: "One of the best means of language-training is reading a selection to a grade or class, and requiring them to reproduce it in writing. The value of such exercises consists in the natural and easy way in which the pupil gains a command of language. Written reproductions from memory form the best basis to lead into original composition, and what, moreover, is of the utmost importance, they give the pupil an opportunity by his own practice to discover his errors and inaccuracies, and to work out of them. Through careful and suggestive criticism by the teacher, all the principles of composition become known; not, of course, in a formulated way, but in that way which gives the pupil power to avoid errors without being hampered by rules." The aim has been to supply a series of exercises suitable for such reproductions. The book is divided into three parts, of which the first consists of selections purely narrative or descriptive in character, such as experience has proved are best adapted for beginners. In the second part, the selections contain quotations, and are more difficult of punctuation; and the third part contains matter adapted to advanced grammar grades and classes in rhetoric. Suggestions to teachers are given at the beginning of each part.

UNITED STATES COMMISSION OF FISH AND FISHERIES. Report of the Commissioner for 1883. Washington: Government Printing-Office. Pp. 1206, with numerous Plates.

THE Commissioner reports a great extension of the possibilities of usefulness of the Commission, by means of the steamers with which it has been furnished; and much has been attempted as well as accomplished. In addition to the regular work of the Commission, it has become possible to do a great deal for the advancement of science in general, especially by prosecuting researches into the general natural history of animals and plants. The very large collections made by the Commission, after setting aside a full series for the National Museum, have been divided into arranged, classified, and labeled sets, and distributed to colleges, academies, and other institutions of learning throughout the United States. Among the objects which the Commission hopes to accomplish are the continued acquisition of information respecting fresh- and salt-water fish; improvement of old methods and apparatus of fishing and the introduction of new ones; improvement in the pattern of fishing-vessels; to determine the extent and general character of the old fishing localities, and discover new ones; to improve methods of curing and packing fish for market; and continued increase in the supply of valuable fishes, etc., in the waters of the United States. The present report contains many articles of general value. Among them are accounts of the species of fish cultivated and distributed in 1883; accounts of the work of the steamer Albatross, by Lieutenant-Commanding Tanner, and of its results in natural history and biology, by A. E. Verrill and Katherine J. Bush, liberally illustrated; and reports on the propagation of food-fishes at the several stations. Doubtless, these papers, a large number of which are published as an appendix to the report, are all of great value to some persons; but they are not of equal value to all. It is not desirable that any one wishing for one or a few of them should be burdened with so unwieldy a volume as the one before us. It would perhaps be as well to publish many of them in separate volumes, accessible to the general public, as well as in the ponderous shape in which they now appear.

FOURTH REPORT OF THE UNITED STATES ENTOMOLOGICAL COMMISSION. By CHARLES V. RILEY. Washington: Government Printing-Office. Pp. 550, with Plates.

THIS report is essentially a revised edition of the Commission's Bulletin No. 3, and is the final report on the cotton-worm, together with a chapter on the boll-worm. The cotton-worm investigation was begun in the spring of 1878, under an appropriation of five thousand dollars, and has been conducted with the purpose of getting at the exact truth, and for practical ends. Hence purely entomological knowledge has been subordinated to that which may be made of practical use to the planter; and descriptive matter

and technical discussions have been for the most part excluded from the body of the work and printed at the end of the volume in notes. The wider application than that to the special object of the research of which many discoveries are susceptible is illustrated in the modern very general use by farmers and fruit-growers, in all parts of the country, of pyrethrum in the field, of petroleum emulsions, and of the cyclone spraying-nozzle, all of which have had their origin in this investigation. The report gives a full account of the cotton-worm, its character, habits, and history; of the influences that affect it, its natural enemies, the preventive measures to be taken against it, and the remedies, and machinery, and devices for accomplishing its destruction; a chapter on the boll-worm; and a number of special reports in the Appendix.

DUFFY'S WAVE-MOTOR AS A SOURCE OF POWER FOR VARIOUS PURPOSES. By TERENCE DUFFY. San Francisco: 948 Gerry Street. Pp. 15.

MR. DUFFY has sought an invention to utilize the enormous energy of waves as a source of power, and for the movement of mechanism. He has devised a buoy, with internal arrangements and machinery by which a set of pumps shall be set in motion by the undulations to which it is subjected, to supply a reservoir of compressed air; this air to be applied to any purpose for which it may be desired. Among the applications suggested in the pamphlet are the generation of electricity; signal, relief, and light stations; propulsion of vessels; and the movement of machinery on shore. The structure of the buoy, with all its chambers and mechanism, and the application to these purposes, are set forth in the pamphlet. We see nothing in the text, however, from which we are enabled to affirm that the author has set up one of his buoys and put it to an experimental test.

THE AMERICAN JOURNAL OF BIOLOGY. Quarterly. Edited by H. D. VALIN, M. D. Chicago: Published by the author. $1 a year.

THE "Journal," according to the editor's prospectus, is devoted to the study of life and mind in its widest sense, and will consist mainly of articles written especially for its pages by persons competent to treat the subject. Each number is intended to contain sixty pages. The present number is published with only forty-four pages, but with a promise to make up the deficiency in the next number, which will consist of seventy-six pages. It contains papers on "The Laws of Life outlined," "Origin of Flowers," "Nature of Animal Colors," "Nature of Light," "Development of the Eye," and "Nature of Sight," and selections.

MECHANICS OF THE GIRDER. A Treatise on Bridges and Roofs. By JOHN DAVENPORT CREHORE, C. E. New York: John Wiley & Sons. Pp. 575. Price, $5.

IN this purely technical treatise, the necessary and sufficient weight of the structure is calculated, not assumed; and the number of panels and height of girder that render the bridge-weight least for a given span, live load, and wind-pressure, are determined. The book is presented just as it was left at the author's death, in October, 1884, with the carrying out of only a few examples in the twelve classes of girders still remaining to be done. Of these examples, the post-truss promised to yield the most prolific results; and it may be possible, the editor hopes, "before another edition is published, to complete this calculation at least, if not to introduce other examples from the later classes. However, the *a priori* method of the author is fully set forth previous to the tenth chapter; and it is believed that no one else has as yet published any so satisfactory results from this method, if, indeed, the method has been hitherto attempted with any degree of success." The work has been prepared for the press under the supervision of Professor John N. Stockwell, who has also undertaken the task of completing the remaining examples for future editions.

BULLETIN OF THE UNITED STATES GEOLOGICAL SURVEY. Nos. 27, 28, and 29. Washington: Government Printing-Office. Pp. 80, 59, with Plates and Map, and pp. 24, with Plates.

No. 27 is an account of the work done in the division of Chemistry and Physics, mainly during the year 1884–'85. Among the papers are one on "Topaz from Stoneham, Maine"; a memoir, by F. A. Gooch, on the

separation of titanium and aluminum; investigations by C. Barus and V. Strouhall on electrical resistance and density, and oxide films on steel; and miscellaneous analyses. No. 28 is an account of the gabbros and associated hornblende rocks occurring in the neighborhood of Baltimore, Maryland, by Professor George Huntington Williams, of Johns Hopkins University. No 29 is a memoir on the fresh-water invertebrates of the North American Jurassic, by Charles A. White, M. D.

DISINFECTION AND INDIVIDUAL PROPHYLAXIS AGAINST INFECTIOUS DISEASES. By GEORGE M. STERNBERG, M. D. Concord, N. H. Pp. 40.

THIS essay is published by the American Public Health Association as one of the four papers on as many subjects of public sanitation, for which the prizes offered by Mr. Henry Lomb, of Rochester, New York, were awarded. The author, who has long been pursuing a scientific and practical study of all that relates to microbic infections, has in it explained the nature and office of disinfection and disinfectants, with the value and effect of the different substances in general use, and directions for application and for individual prophylaxis against the infectious diseases which man is liable to contract. The essay is designed for general use, and is, therefore, free from technicalities, and is for sale at "a price covering the cost," which we do not find specified.

THE RELATION OF HOSPITALS TO MEDICAL EDUCATION. By CHARLES FRANCIS WITHINGTON, M. D. Boston: Cupples, Upham & Co. Pp. 47.

DR. WITHINGTON starts out with the proposition that measures not distinctly contemplated by the founder of a trust may, in the course of time or by changes in conditions and circumstances, become necessary to the truest fulfillment of the spirit of the trust. Among such measures is the use of hospitals as aids in medical education. Two objections may be brought against this view: one, that while the advancement of medical education is for the advantage of all men, there is no special obligation resting upon hospitals more than upon the general medical profession to contribute to it; and that the use of a hospital for such purposes may be in conflict with the comfort and well-being of the persons under treatment. These objections are answered: First, it is held that, since hospitals possess certain facilities for the advancement of medical science, having relation to important elements in medical education that are not enjoyed elsewhere, they are under a peculiar obligation to second this work; next, the possible conflict between the interests of medical science and those of the individual patient is considered, and the latter's indefeasible rights are defined; and in a third section the factors increasing the educational value of hospitals are discussed.

THE JOURNAL OF PHYSIOLOGY. Edited by MICHAEL FOSTER, M. D. Vol. VII. Nos. 3 and 4. Cambridge, England. Pp. 164. Price, $5 a volume.

DR. FOSTER has the co-operation in conducting the "Journal of Physiology," in England, of Professor W. Rutherford, of Edinburgh, and Professor J. Burdon-Sanderson, of Oxford; and in the United States, of Professor H. P. Bowditch, of Boston; Professor H. Newell Martin, of Baltimore; and Professor H. C. Wood, of Philadelphia. The numbers appear, not at rigidly fixed times, but at varying intervals, which are determined by the supply of material. The two numbers now under notice contain fifteen articles descriptive of original physiological research, by W. M. Bayliss and J. R. Bradford, J. W. Barrett, C. A. MacMunn, M. Greenwood, S. Pallitzer, Sydney Ringer, F. W. Ellis, Francis Warner, W. D. Haliburton, and R. Norris Wolfenden. The papers of most general interest are, perhaps, those of S. Pallitzer on "Curare," and R. Norris Wolfenden on "The Nature and Action of the Venoms of the Indian Cobra and the Indian Viper."

FIRST ANNUAL REPORT OF THE FOREST COMMISSION OF THE STATE OF NEW YORK FOR THE YEAR 1885. Townsend Cox, Sherman W. Knevals, and Theodore B. Basselin, Commissioners. Albany: The "Argus" Company. Pp. 362.

THE commission was appointed in pursuance of an act of the Legislature of May 15, 1885, and held its first meeting on the 23d of September of the same year. Its functions, as defined in the act constituting

it, are to have the care, custody, control, and superintendence of the forest preserve; maintain and protect the existing forests and promote the further growth of forests; also to have charge of the public interests of the State with regard to forests and tree-planting, and especially with regard to forest fires in every part of the State; and it is given power to make these functions effective. The forest preserve of the State consists of various tracts of State lands in eleven counties in the Adirondack region and three counties in the Catskills. The part known as the Adirondack region covers a territory circular in its general outline and about one hundred miles in diameter, having its center near the northeast corner of Hamilton County. With but little exception, it is an unbroken wilderness, reaching from Lake Champlain westward to the valley of the Black River. That part of the Catskills which belongs in the forest preserve is situated about forty miles west of the Hudson, and occupies the northwest corner of Ulster County, together with parts of the adjacent counties. The Adirondack region proper contains more than four million acres, of which the State has acquired title to more than eight hundred thousand acres. In the Catskill region the State owns more than five hundred thousand acres. These amounts do not include the county lands in the Adirondacks and Catskills. Not all the land is forest-land. Much of it is abandoned and partly cleared farming-lands, much burned lands, and a large percentage of it abandoned timber-lands through which the lumberman has passed, taking all of the valuable soft timber and much of the hard. As years go on, and these woods are protected from spoliation and damage, the young, soft-timber trees will grow up and the forest assume its primitive condition. The rest of the territory is clothed with the dense original growth. Many good roads traverse the region, but few railroads penetrate the wilderness to any considerable extent, and none cross it. The forest preserve is made up of many disconnected plots, more in some counties than in others; plots ranging from a few acres up to many thousands, surrounded usually by lands owned by individuals, and in many cases inaccessible by roads. In other cases individual lands are entirely surrounded by State lands. Among the causes which tend to decrease the area of the forest-lands within the counties of the forest preserve are mentioned fires—the most frequent and the most destructive of them all—windfalls and land-slides, lumbering, tanning—which is the occasion of considerable waste—manufacture of wood-pulp, charcoal-burning and roasting ores, railroad-building, and farming. Although the forestry enterprise was at one time an object of opposition from the people of the Adirondack counties, a better acquaintance with the subject has wrought a modification in their feelings, and the report mentions as a matter worthy of note and congratulation that the commission is to-day receiving a hearty and intelligent support from the lumbermen and land-owners of the Adirondack region and the Catskills. Appended to the report are a list of the books and magazine articles pertaining to forestry to be found in ten of the large public libraries of the country, and a list of lands in the forest preserve, with a map of the Adirondack lands.

REPORT OF THE UNITED STATES ENTOMOLOGIST FOR THE YEAR 1885. By CHARLES V. RILEY. Washington: Government Printing-Office. Pp. 150, with Plates.

IN the report we find an essay on silk-culture, followed by notices, under the heading of "Miscellaneous Insects," of the destructive locusts or grasshoppers; the periodical cicada (or seventeen-year locust); the leather beetle, a new enemy to boots and shoes; the garden web-worm, the dark-sided cut-worm, the strawberry weevil, and the pear-midge. The "reports of agents" include notices respecting locusts at various points, insects affecting the fall wheat, the causes of destruction of the evergreen and other forest trees in Northern New England, and experiments in apiculture. Under the latter head Mr. Nelson W. McLain records, among other matters, experiments which he made to ascertain whether bees do harm to fruit. His bees were tempted with grapes, while other food was withdrawn from them, and the conditions of a severe drought were produced upon them. "They daily visited the fruit in great numbers, and labored diligently to improve

the only remaining source of subsistence. They inspected and took what advantage they could of every opening at the stem or crack in the epidermis, or puncture made by insects which deposit their eggs in the skin of grapes. They regarded the epidermis of the peaches, pears, plums, and other fruits having a thick covering, simply as subjects for inquiry and investigation, and not objects for attack. If the skin be broken or removed, they will, in case of need, lap and suck the juices exposed. The same was also true of the grapes if the skin was broken by violence or burst on account of the fruit becoming overripe; the bees lapped and sucked the juices from the exposed parts of grapes and stored it in the cells for food. They made no attempt to grasp the cuticle of grapes with their mandibles or with their claws. So, in every experiment, bees were found not able to puncture the skins of fruits, or even to take advantage of punctures made by other insects, unless they were of considerable size."

REPORT OF THE PROCEEDINGS OF THE AMERICAN HISTORICAL ASSOCIATION. Second Annual Meeting. By HERBERT B. ADAMS, Secretary. New York: G. P. Putnam's Sons. Pp. 73. Price, 50 cents.

THE meeting was held at Saratoga, New York, from the 8th to the 10th of September, 1885, and was attended by fifty members, representing various parts of the country, many institutions of learning, and several historical societies. The meeting of the American Social Science Association at the same time and place, and the attendance of several American librarians whose meeting was in session at Lake George, are mentioned as features adding to the interest of the occasion; and the organization of the American Economic Association under the same roof with, and in the reading-rooms of, the American Historical Association, at hours not conflicting with the latter's appointments, was another notable event in the records of the conventions. All of these bodies are in harmony with one another, and to a certain extent co-operative and complementary of each other's efforts. The report contains abstracts of the papers that were read at the meeting: By President Andrew D. White, on "The Influence of American Ideas upon the French Revolution"; by Goldwin Smith, on "The Political History of Canada"; by Jeffrey R. Bracket, on "Certain Studies in the Institution of African Slavery in the United States"; by Justin Winsor, on certain old maps; by Professor Tuttle, of Cornell University, on new materials for the history of Frederick the Great of Prussia; by Professor Emerton, of Harvard University, on Janssen's account of the Protestant Reformation, and the work of Luther; by Bishop Robertson, on "The Purchase of Louisiana, and its Effects upon the American System"; by Miss Lucy M. Salmon, on "The History of the Appointing Power of the President"; by John Addison Porter, on "The City of Washington: its Origin and Administration"; by Mr. Irving Elting, on "Dutch Village Communities on the Hudson River"; by Dr. Josiah Royce, on "The Secret History of the Acquisition of California"; by Dr. J. F. Jameson, on the study of the constitutional and political history of the individual States; by Dr. Edward Channing, on his index of maps bearing on our early history; by President White, on "The Development of the Modern Cometary Theory"; by General Cullum, on the disposal of Burgoyne's troops after the Saratoga Convention of 1777; by the Hon. Eugene Schuyler, on "Materials for American History in Foreign Archives." The reading of several of these papers was followed by interesting discussions. Davis R. Duvey made a report on a proposed "History of American Political Economy," which had been undertaken by Dr. Ely, Mr. Woodson Wilson, and himself. An historical map of Pennsylvania, by Mr. P. W. Sheafer, was exhibited and described. The Association recommended the organization of local historical societies, and the careful collection and preservation by them of everything which is or may become of historical interest, or a source of historical knowledge; it passed a testimonial resolution in honor of Leopold von Ranke, whom it elected its first honorary member; and it suggested to the Government the advisability of cataloguing all documents relating to the history of the United States down to 1800, existing in the official and private archives of Europe, and of copying and printing the most important of them.

THE GRAMMAR-SCHOOL READER. A Monthly Magazine. Vol. I, No. 1. Chicago and Boston: Interstate Publishing Company. Pp. 48. Price, 15 cents; $1 a year.

THIS is the highest of a series of three monthly readers which the Interstate Publishing Company have projected. The other readers of the series are the Primary, twenty cents a year, and the Intermediate, thirty cents a year. The present number is filled with lively articles and stories. In the department, "Ways to do Things," is an illustrated paper on "Knots, Hitches, and Splices," which the young constituency of the "Readers" might turn to practical advantage.

THE HYGIENE OF NATURE; OR, NATURAL SELECTION AND IMMUNITY FROM DISEASE. By Dr. ROMAINE J. CURTISS. Joliet, Ill. Pp. 18.

AN argument to show that Nature removes epidemics and such diseases as work great destruction for a course of years and then nearly disappear, by her own processes, constituting a natural selection, while sanitation is not entitled to the credit it claims for the extinction of such disorders. Applying his doctrine to the history of the epidemics of the middle ages, and to the shortness of life during that epoch, Dr. Curtiss says: "We find that when an epidemic prevailed it destroyed everybody who had not sufficient vital resistance. . . . Those who could sufficiently resist the disease, or who could acquire a resistance, lived and bequeathed the resistance to their children. In time, by this process, each generation acquired more and more resistance to each of the epidemics, and in time there was nothing left for the parasites of the great European epidemics to do except to acknowledge the survival of the fittest, whose name is Man." This immunity may be lost by atavism; and, when so lost, there will be a liability to the recurrence of great epidemics.

EASY LESSONS IN FRENCH. According to the Cumulative Method. By ADOLPH DREYSPRING. New York: D. Appleton & Co. Pp. 142. Price, 70 cents.

WE have already expressed appreciation of the merits of Professor Dreyspring's "Cumulative Method" in German, and of the happy application which—so far as books can go—he has made of it. With that application living in the schools, it was, as the author well says, a foregone conclusion that the system should in time be adapted to the acquisition of the French language. The present book represents the first step in such adaptation. The distinctive features of the method are presentation of the normal phases of the language first; selection of its elementary material, with special reference to what is usually in sight; development of the first needs of speech, as manifested by the simplest ordinary inquiries; unfolding the language out of itself; a vocabulary within reasonable bounds; a constant revolving of the accumulating material under ever varied forms and new combinations; and special care to interest the student and to preserve his enthusiasm for the study. The author maintains that his method is a decided revolt from the old practices, and that, as an initiatory step, it strenuously avoids the declensional and verbal pabulum usually administered to students. It opens its attacks upon points in the language offering the least resistance, such as nouns, adjectives, and prepositions, with the connective *is;* and it gives the preference to the descriptive power of speech over the volitive. Illustrations are given as aids to the lessons, and to make them more attractive and impressive. In the use of the work, the author insists on repetition, distinct and loud reading, and faithful practice of the verb-drill; when, he believes, its merits will not fail to be recognized.

THE THREE SYSTEMS OF LIFE INSURANCE. By MERVIN TABOR. Chicago: Bureau of Life-Insurance Information. Pp. 236. Price, $2.

THE author of this book is Actuary of the Insurance Department of Illinois, and Manager of the Bureau of Life-Insurance Information. He has written it, he says, for the general public and for life-insurance agents and solicitors; and upon the suggestion of many letters which have been received at the Bureau, asking for information in a wide range of inquiry upon subjects involving the elementary principles of life insurance. The "three systems" mentioned in the title are designated as "The Level Premium," "The Natural Premium," and "The

Assessment" systems, each of them having advantages peculiar to itself, and being adapted to the wants of different classes of insured. The merits and workings of each are explained in detail, and their especial adaptations are elucidated. Besides the matter bearing immediately upon these points and also upon endowment, tontine, and semi-tontine insurance, the book contains the two leading mortality tables in use in this country; definitions and explanations, with illustrative examples, of the technical terms and expressions often used by agents and solicitors; articles on the failures of life-insurance companies, and their expenses in comparison with those of fire-insurance and railroad companies; interest and discount tables; an explanation of the construction of mortality tables; an article on the law of mortality and the wonderful precision with which it operates; and much other matter appropriate to the general subject of the book.

A DIRECTORY OF AUTHORS, INCLUDING WRITERS FOR THE LITERARY MAGAZINES. Compiled by W. M. GRISWOLD. Bangor, Maine: Office of the "Monthly Index." Pp. 16. Price, 50 cents.

THIS edition contains the additions and emendations to the list of authors published in the first edition of the Directory. Five hundred and ninety-six names of authors are enrolled, only the names of many of them being given, the accounts of whom can be found in the former edition. The compiler acknowledges that his Directory is incomplete—it is not within human possibilities to give such a work an approach to perfection till after many repeated efforts. He depends upon the authors themselves to remedy its defects, by furnishing him answers to the inquiries which he has sent out in his circular.

A NEW PHILOSOPHY OF THE SUN. By HENRY RAYMOND ROGERS, M. D. Dunkirk, N. Y. Pp. 27.

THIS is the substance of a paper which was read before the Chautauqua Society of History and Natural Science. It presents a theory that the sun is not hot or brilliant, but is simply a propagator of force—presumably electric force—the working of which in our atmosphere produces the calorific and luminous manifestations commonly regarded as solar.

A NAVAJO SKULL, with an Additional Note on the same. By Professor Sir WILLIAM TURNER. Pp. 4, with Plate, and 2; OSTEOLOGY OF CONURUS CAROLINIENSIS. Pp. 16, with Plate. By R. W. SHUFELDT, M. D.

THE first and second of these monographs relate to the examination of the skull of a Navajo Indian of about forty years of age, who came to his death by a gun-shot wound of the head. The third paper is an investigation of the bony structure of the Carolina parrot.

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## PUBLICATIONS RECEIVED.

Garrison, F. Lynwood, Philadelphia. The Microscopic Structure of Car-Wheel Iron, pp. 7. The Microscopic Structure of Iron and Steel, pp. 12.

Martin, Lillie J., Indianapolis, Ind. Chemistry in the High-Schools. Pp. 12.

Hale, Horatio. The Origin of Languages, and the Antiquity of Speaking Man. Pp. 48.

Jastrow, Joseph, Johns Hopkins University. The Perception of Space by Disparate Senses. Pp. 16.

Bell, Clark. Report on Classification of Mental Diseases. Pp. 14.

Packard, S. W., Chicago. Review of the Anti-Saloon Republican Convention. Pp. 16.

Crothers, T. D., Hartford, Conn. Temperance, Parties, and Politics. Pp. 3.

Peabody Museum of American Archæology and Ethnology. Eighteenth and Nineteenth Annual Reports of the Trustees. Cambridge, Mass. Pp. 128.

Agricultural College of Michigan. Notes on Tomatoes. Pp. 15.

Levermore, Charles H. The Town and City Government of New Haven. Baltimore: N. Murray. Pp. 103. 50 cents.

Munroe, Charles E. Index to the Literature of Explosives. Part I. Baltimore: Isaac Friedenwald. Pp. 42. 50 cents.

Dulles, Charles W., M. D. The Mechanism of Indirect Fractures of the Skull. Philadelphia: P. Blakiston, Son & Co. Pp. 55, with Plates.

Smith, Eugene A., Ph. D., State Geologist. Geological Survey of Alabama. Bulletin No. 1. Pp. 86, with Nine Plates.

Commissioners of Fisheries, State of New York. Fourteenth Report. Albany: Weed, Parsons & Co. Pp. 209.

Sechrist, S. P. Sechrist's Hand-Book and Railway Equipment and Mileage Guide. Monthly. Cleveland, Ohio: J. B. Savage. Pp. 190.

Bell, Alexander Melville. English Line Writing (Phonetic). New York: Edward S. Werner. Pp. 52. 60 cents.

Stephenson, F. B., M. D. Arabic and Hebrew in Anatomy. Pp. 10. Sydenham and Hahnemann. Pp. 6.

Stowell, T. B. The Vagus Nerve in the Domestic Cat, pp. 16. The Trigeminus Nerve in the Domestic Cat, pp. 20.

Commissioner of Pensions. Annual Report, to June 30, 1886. Washington: Government Printing-Office. Pp. 70.

Grey, Maxwell. The Silence of Dean Maitland. New York: D. Appleton & Co. Pp. 372. 50 cents.

Holbrook, M. L., M. D. How to strengthen the Memory. New York: M. L. Holbrook & Co. Pp. 152. $1.

Wilson, George. A Hand-Book of Hygiene and Sanitary Science. Philadelphia: P. Blakiston, Son & Co. Pp. 520. $2.75.

United States National Museum. Proceedings. Vol. VIII, 1885. Washington: Government Printing-Office. Pp 729, with Plates.

Smithsonian Institution. Report of the Board of Regents for 1884. Washington: Government Printing-Office. Part II. Pp. 458.

McLennan, the late John Ferguson. Studies in Ancient History. New York: Macmillan & Co. Pp. 387. $4.

Ayer, N. W. and Son. American Newspaper Annual, 1886. Philadelphia: N. W. Ayer & Son. Pp. 1010. $3.

Brown, Walter Lee. Manual of Assaying Gold, Silver, Copper, and Lead Ores. Chicago: E. H. Sargent & Co. Pp. 487. $2.50.

Rosenkranz, Johann Karl Friedrich. The Philosophy of Education. New York: D. Appleton & Co. Pp. 256. $1.50.

Mallock, W. H. The Old Order changes. New York: G. P. Putnam's Sons. Pp. 513. $1.

Anders, J. M., M. D. House-Plants as Sanitary Agents. Philadelphia: J. B. Lippincott Company. Pp. 334. $1.50.

Owen, Catherine. Ten Dollars Enough. Boston and New York: Houghton, Mifflin & Co. Pp. 279. $1.

Bert, Paul. First Series in Scientific Knowledge. Philadelphia: J. B. Lippincott Company. Pp. 370. 60 cents.

Johnson, J. B., C. E. The Theory and Practice of Surveying. New York: John Wiley & Sons. Pp. 683.

Bancroft, Hubert Howe. History of the Pacific States of North America. Vol. XXIV. Oregon. Vol. I. 1834–1848. San Francisco: The History Company. Pp. 789.

Gore, J. Howard. Elements of Geodesy. New York: John Wiley & Sons. Pp. 282.

Reed, Lieutenant Henry A. Topographical Drawing and Sketching, including Applications of Photography. New York: John Wiley & Sons. Pp. 129, with Plates. $3.50.

## POPULAR MISCELLANY.

**The State and Public Health.**—Professor Edward Orton, in an address before the Ohio State Medical Society, on "The Relation of the State to the Health of the People," asserts that "the manner in which we are doing much of our sanitary work is far below the best knowledge of our time, and is a serious reproach upon our civilization. We are expending enough, and more than enough, to give us ample protection from the diseases which threaten us, but our ill-devised plans and our worse-constructed work leave us still, to a large degree, within their power." There is much truth in this, and the reason for it is perhaps to be found in the fact that too much is done for the sake of doing, without taking sufficient pains to do intelligently. Professor Orton would remedy the evil by putting all local sanitary work under the control of municipal boards of health, "which should be measurably permanent bodies, and which should be intrusted with large powers." The quality of permanence should be insisted upon, that the boards may profit by their mistakes, and learn as they go, and not, being renewed every little while, go on repeating the mistakes of their predecessors or blundering into new ones. Then Professor Orton would have the work of these local boards unified under a State Board—an important matter, in consideration of the extensive geographical fields that often come under common sanitary relations. Such general supervision is particularly called for in a State situated as Ohio is, which, through most of its area at least, must depend for the future, as it does in the present, upon its rivers and lakes for its water-supply; and the question of guarding these sources becomes one of the gravest importance, which a State Board or its equivalent only is competent to deal with.

**Bacterial Products as Antidotes for Bacteria.**—D. E. Salmon communicated to the American Association the results of experiments which he had made in neutralizing the pathic effects of bacteria by means of the chemical products of bacterial action. They had been made upon pigeons with the bacteria of the swine-plague virus and their products. Since the demonstration of the germ theory of disease, it has become evident that there are three possible explanations of the action of these products: 1. Something is deposited in the body during the attack of disease that is unfavorable to the specific germ. 2. Something is exhausted which is essential to the development of the germ. 3. The living tissues acquire such a tolerance for the germ, or for a poison which it produces, that they are no longer affected by it. If either the first or the third of these explanations is correct, it would appear possible that immunity might be gained by introducing into the tissues the liquids in which the specific germs have been cultivated, and from which they had been removed by filtration, or in which they have been killed by suitable methods. The

speaker had long been convinced of the correctness of this supposition, but it was only recently that he had been able to make a satisfactory demonstration of the principle.

**Visions of the Blind.**—Mr. J. Jastrow had an interesting paper, at the American Association, on "The Dreams of the Blind." Vision in dreams is connected with a recollection of sight, and the fact of its manifestation would mean that in the dreamer's brain there is developed a sight-center, the spontaneous activity of which is the material substratum of his dreams. Brain-centers, we know from observation and experiments on animals, are of slow growth. By asking what is the latest age at which a child may become totally blind and still retain dream-vision, we will be asking how long a time is necessary for the sight-center to develop, and sufficiently to enable it to function without further retinal stimulation. "Two hundred blind persons (mostly young) in the institutions for the blind at Baltimore and Philadelphia, were questioned in detail in regard to their dreams, and from their answers I conclude that the critical age is between the fifth and the seventh year. Those losing their sight before this age have no more vision in their dreams than if they were blind from birth. Those who become blind during this period may or may not lose dream-vision; while those whose eyesight is destroyed after this period find themselves quite on a par with seeing persons in dream-life. Only cases of total blindness are employed as a basis for this conclusion. With regard to cases of partial blindness it is found that the same period divides those whose dream-vision is brighter and more vivid than the partial sight of waking life from those whose waking life furnishes, though filled with imperfect sensations of sight, the material for dream-images."

**The Cause of the Charleston Earthquake.**—The theories of the causes of earthquakes are almost as various as the phenomena themselves; and it is the general opinion of those who have most carefully studied the subject that no single cause is competent to account for all that occur. The most evident fact about the cause of the recent shocks by which Charleston has been afflicted is, that there is nothing volcanic about it. Otherwise, our geologists incline to the belief that they are the concomitant of a line of weakness extending near the Atlantic coast from about Troy, New York, by Baltimore, Washington, and Richmond, to the Carolinas, and that the phenomena were immediately the result of a renewed faulting or displacement in the latter region. Tidal action may have had something to do with it; and notice has been taken of the fact that at the time of the severe shock at Charleston, the moon had been new, at perigee only about sixty hours, or a fair time for the accumulation of the effect, previous to its occurrence. The fact particularly illustrates Perrey's theory of tides of the fluid interior of the earth. How little, however, is really known about the causes of this or of any other earthquake is somewhat amusingly illustrated by a remark of Professor Dawson's the day after he had delivered his address as President of the British Association, and after the news had reached him of the disaster in Charleston. "The phenomena of the present earthquake convulsions in America and elsewhere, but particularly in America," he said, "are extremely puzzling, and completely upset some of the conclusions set forth in the address I read last evening." The Geological Survey has sent out a circular asking from observers as definite statements as they can obtain respecting the details of the phenomena. The questions have reference to the perceptible occurrence of the shock; its exact hour, minute, and second in standard time; the duration of the shocks; the accompanying noise, if any; the number, etc., of the shocks; the measure of intensity—whether very light, light, moderate, strong, or severe; the possibility of the existence of any other cause for what happened than an earthquake; and whatever other particulars of interest may have been noticed or learned by hearsay.

**Mr. Darwin on Geologic Time.**—Mr. G. H. Darwin, President of the Geological Section of the British Association, made a survey of the theories of geological time, including those of Mr. Croll and Sir William Thomson, and concluded from them that something has been acquired to our knowl-

edge, but that much more remains still to be determined. It seems as likely that in this problem geology and meteorology will pass the word of command to physics as the converse. At present our knowledge of a definite limit to geological time has so little precision that we should do wrong to reject summarily any theories which appear to demand longer periods of time than those which now seem allowable. In each branch of science hypothesis forms the nucleus for the aggregation of observation, and as long as facts are assimilated and co-ordinated we ought to follow our theory. Thus, even if there be some inconsistencies with a neighboring science, we may be justified in still holding to a theory, in the hope that further knowledge may enable us to remove the difficulties. There is no criterion as to what degree of inconsistency should compel us to give up a theory, and it should be borne in mind that many views have been utterly condemned when later knowledge has only shown us that in them we were only seeing the truth from another side.

**An Inventory of the Glacial Drift.**—Vice-President Chamberlin, in his address before the American Association's section of Geology and Geography, presented "An Inventory of our Glacial Drift." Having described the boundaries of the drift as represented on a wall-map, the speaker remarked that a wealth of significance lay in the sinuosities, vertical undulations, and varying characters of the southern border. It undulates over the face of the land essentially much as an arbitrary line from New York Harbor to Puget Sound, and could be reduced to horizontality—as it must have been to have marked the margin of some ancient ice-bearing body of water—only by incredible warpings and dislocations. The border presents three notable phases: one part terminating in a thickened belt, a terminal moraine; another in a thin margin; and a third in an attenuated border of scattered pebbles. The morainic border prevails in the Atlantic region and on or near the limit as far west as Central Ohio. Throughout the rest of the stretch to the Rocky Mountains the attenuated edges prevail. Of unstratified bowldery clays or tills, there is the richest variety, ranging through diverse combinations of material, texture, and aggregation. Of moraines, terminal, lateral, medial, and intermediate varieties are found. The great terminal moraines overshadow all others in interest and importance. Outside of the chief moraines are occasional belts of older drift aggregated in the similitude of peripheral moraines. Back from the two principal terminal moraines lie similar partially determined belts, usually of less prominence and continuity. Our most unique moraines are the interlobate, developed between the tongues into which the ice-sheet of the second epoch was divided at its margin, of which about a dozen, in half as many States, are recognized. Beautiful lateral moraines abound in the mountainous regions of the West, and some were developed by local glaciation supervening upon the ice retreat of the East. Our medial moraines are unimportant, and confined essentially to mountainous glaciation. Allied to the true moraines are special forms of aggregation of the sub-glacial *débris*. Two classes commonly embraced in the assorted drifts should be excluded from them: the "orange sands" of the Mississippi Valley, which do not appear to possess the distinctive characteristics of glacial gravels, but are residuary in aspect; and the secondary drifts, or those that have been reworked by wholly non-glacial agencies. Eliminating these, two classes of products of glacial waters working co-ordinately with the ice are recognized: those that gathered immediately within and beneath the ice-body itself, or against its margin; and those which were borne to distances beyond its limit by the glacial drainage or by peripheral waters. The products embrace a great variety of sub-types of gravel-heapings, including isolated mounds, conical peaks, clustered hummocks with inclosed pits and basins, and sharp, steep-sided ridges, often of phenomenal length, all possessing great irregularities of material and stratification, embracing frequently, manifest disturbances. The elongated variety, resembling the great *osars* of Sweden, are finely developed in Eastern New England; while the hummocky variety, constituting the ill-defined class of kames, are abundant throughout New England, New York, Northern New Jersey, Pennsylvania,

Ohio, Indiana, the greater part of Michigan, Northern Illinois, Eastern and Northern Wisconsin, Northern Minnesota, North-Central Iowa, Eastern Dakota, and many parts of Canada. Of valley drift, attention was directed to the moraine-headed valley trains, and the loess tracts. The former show progressively coarser material toward their origin, and merge into expanded heads, blending with the moraines in which they begin. The broad tracts of fine silt, designated "loess," occupy the Mississippi up to East-Central Minnesota, the Missouri up to Southern Dakota, the Illinois and Wabash up to their great bends, and the Ohio up to Southeastern Indiana. Two other assorted deposits considered were those overspreading the great basin of the St. Lawrence and the Winnipeg basin. These often present, among their surest credentials, overflow channels to the southward, crossing divides sometimes hundreds of feet above existing outlets, and varying in altitude among themselves at least two thousand feet.

**Durability of Water-Color Drawings.**—A controversy, which recently arose in England on the durability of water-color drawings, led to an exhibition of pictures at which visitors were given opportunity to test for themselves the capacity of the specimens shown to hold their colors. The "Saturday Review" draws from the average of the works the conclusions that, in pictures or passages of especially vivid color, little in the way of fading need be apprehended; but, in the delicate, broad, and thin washes of the landscape-painter, "changes of various kinds are apt to take place, capriciously, as it would seem, and from various causes, of which long and continued exposure to light is probably one. Pending more accurate experiments, collectors and managers of public institutions will do well to keep their framed drawings rigorously protected from pure sunlight, and not exposed more constantly than is necessary to ordinary daylight; for which purpose they should be covered with blinds or curtains during the long hours of the summer mornings, and generally when the rooms in which they are hung are disused. Also it will probably be well to vary from time to time the drawings exhibited, and to return each occasionally for a period of rest to the drawer or cabinet. But on the question of frames *versus* portfolios, it has to be remembered that a well-framed drawing is secure at least from effects of atmosphere; while in portfolios it is only by extreme and constant care that risks can be avoided from dust and rubbing."

**Marine Signals.**—Sir James Douglass addressed the Section of Mechanical Science of the British Association on lighthouses and marine signals. There are at present not less than eighty-six distinctive characters in use throughout the lighthouses and light-vessels of the world; and as their numbers increase so does the necessity for giving a more clearly distinctive character to each light over certain definite ranges of coast. This important question of affording to each light complete distinctive individuality is receiving the attention of lighthouse authorities at home and abroad, and it is hoped that greater uniformity and consequent benefit to the mariner will result. There are now about seven hundred fog-signals, of various descriptions, on the coasts of the world; and their construction and operation have been the subject of careful experiment and scientific research. Unfortunately, the results thus far have not been so satisfactory as could be desired. This is owing partly to the very short range of the most powerful of the signals under occasional unfavorable conditions of the atmosphere during fog, and partly to the present want of reliable tests for enabling the mariner to determine at any time how far the atmospheric conditions are against him in listening for the signal. The question of utilizing lighthouses and light-vessels as signal-stations in telegraphic communication with each other and with a central station, has received the consideration of lighthouse authorities generally, and has been made of practical effect in Canada. Buoys are illuminated with compressed oil-gas; and automatic lighting apparatus has been applied to those in occasionally inaccessible positions. A comparative test of the merits of electricity, gas, and mineral oil, as lighthouse illuminants, carried on for twelve months, has given the

following results: 1. That the oil- and gas-lights, when shown through similar lenses, were equally affected by atmospheric variation; 2. That the electric light is absorbed more largely by haze and fog than either the oil- or the gas-light; and, 3. That all three are nearly equally affected by rain. The final conclusions of the committee are that for ordinary necessities of lighthouse illumination mineral oil is the most simple and economical illuminant; and that for salient headlands, important land-falls, and places where a very powerful light is required, electricity offers the greatest advantages.

**Heredity and Education.**—"Heredity and Education; their Relation to Each Other and to the Human Race," is the title of an address by Dr. E. A. Wood, as President of the Pennsylvania Medical Society. The author holds very positive views on the subject, both as to the excellence to which he would have us aim to bring the race, and with regard to the means to be used to reach the end. "If such a man as Shakespeare," he asks, "has lived, why may not men as great as he live again; and if one man attained this greatness, why may not the average man? If the old Greeks reached such perfect development, why may not Americans? Is it possible that we have reached the zenith of our possibilities? Is it not rather probable that Shakespeare approximated but did not attain the possible average of human development? . . . Nature has written all over her page that Newton and Shakespeare were not accidents, but advance heralds, proclaiming the coming man. No man can conceive of the latent potentiality of the human race; by right effort continued in the right direction, man may be developed into a being grander than his loftiest ideals." Further: "Let it be written that many races of men have improved, are improving, and bid fair still further to improve; but man has not improved in accord with his powers and opportunities, has not reached the standard of excellence reached two thousand years ago, and is not improving so rapidly as are the animals domesticated by him. The first step toward race improvement must be to teach our children that reproduction is the highest and noblest function of the animal. We are losing time by not teaching this lesson, and all implied by it, immediately and thoroughly."

**The Future of the Supply of Plant-Food.**—Vice-President Wiley began his address before the Chemical Section of the American Association—which was on "The Economical Aspect of Agricultural Chemistry"—with a rough estimate of the money value of the potash, phosphoric acid, and nitrogen contained in a single harvest, the total of which he placed at $3,343,786,050. This seems to be an enormous quantity of plant-food to be removed from the soil annually, but it must be remembered that it is not all lost; much of it is left in the soil in roots, straw, stalks, etc. But too often the *débris* is got rid of as quickly as possible, and we have in practice not tilling but killing the soil. The stores of plant-food which have accumulated in our virgin soils are indeed great, but they can not withstand this constant drain upon them. The potash that is in the soil may be estimated as enough to last two hundred and fifty years, and the phosphoric acid two hundred and twenty-five years. Immense reserves of both substances are, however, existent and accessible—the potash in feldspathic rocks, and phosphorus in the phosphate-beds. Still, the exportation of agricultural products becomes a slow but certain method of securing soil exhaustion. In point of fact, however, Professor Wiley further showed, the impoverishment of the soil takes place at a much slower rate than the theory announced above would indicate. Doubtless, much reserve food is brought from the subsoil, and, if it be possible for the subterranean stores of these materials to gradually work their way surface-ward, even the remote future need not fear a dearth of them. There is also a certain conservatism in crops, a vegetable "good breeding," which prevents the growing plant from taking all the food in sight. As long as there is abundance, the plant is a hearty eater; but, when the visible quantity of food falls to a certain minimum, it remains for a long time without any rapid diminution. Respecting the nitrogenous food of plants, Professor Wiley presented a series of studies from

which the following conclusions were drawn: 1. The combined nitrogen, which is the product of vegetable and organic life, forms the chief source of nitrogen for the growing plant. 2. Before it is assimilated by the plant, it undergoes a process of oxidation which is due solely to a living organism. 3. The nitrates thus formed are absorbed by the plant, and the albuminoids of the new growth are formed from the nitric nitrogen by a process of reduction. The nitrates themselves are subject to the action of a ferment by which a deoxidation takes place, and free nitrogen and nitrous oxide are evolved. 4. The diminution in the quantity of available nitrogen thus supplied is restored by the fixation of free nitrogen, by the action of organisms in the soil, or by the oxidation of free nitrogen by the interior cells of the plant acting in a manner analogous to the nitric ferment in the soil, or by the oxidation of free nitrogen by electrical discharges or by combustion. 5. The quantity of combined nitrogen brought to the soil and growing plant by the rain-water and the atmosphere, arising from the last two phenomena, is an inconsiderable amount when compared with the whole weight required by the crop. Concerning the future food-supply, Professor Wiley said: "Since, with a proper economy, the natural supplies of potash and phosphoric acid may be made to do duty over and over again, and last indefinitely, the economist, who looks to the welfare of the future, need have no fear of the failure of these resources of the growing plant. Indeed, it may be said that the available quantities of these may be increased by a wide practice of agriculture based on the teachings of agricultural chemistry. But with the increase of population comes an increased demand for food, and therefore the stores of available nitrogen must be enlarged to supply the demands of the increased agricultural product. It is certain that with the new analytical methods, and the question raised by the investigations, many series of experiments will be undertaken, the outcome of which will definitely settle the question of the entrance of free nitrogen into vegetable tissues. If this question be answered affirmatively, agricultural science will not place bounds to the possible production of foods. If the nitrifying process goes on within the cells of plants, and if living organisms do fix free nitrogen on the soil in a form in which at least a portion of it may be nitrified, we may look to see the quantities of combined nitrogen increased *pari passu* with the needs of plant-life. Thus, even intensive culture may leave the gardens and spread over the fields, and the quantities of food suitable for the sustenance of the human race be enormously increased."

**Evolution of Means of Defense.**—Mr. Charles Morris, in a paper of the Academy of Natural Sciences of Philadelphia, on "Attack and Defense as Agents in Evolution," suggests that the various modifications which are seen in the hard parts of animals at different periods indicate adaptation to dominant ideas that have different relations to the prevailing conditions of existence of the time. The earliest animals were probably wholly soft, and have left no remains except an occasional track on the mud of their day. Then came in armored forms with external shells. Swift-swimming armored animals came in with the fishes, and seem to have increased in thickness and weight of armor to the end of the Devonian era. "If, now, we come down to a later era of life, we find in operation what seems a third idea of Nature. The prevailing tendency in animal life is no longer to assume armor, but to throw off armor, and return toward the unprotected condition. The causes of these changes are related to the development of weapons of assault in attacking animals, and to the kind of defense that was most available and useful, or most efficient at the period. As Mr. Morris says: "In the primeval epoch it is probable that only soft-bodied animals existed, and the weapons of assault were the tentacles, the thread-cell, the sucking-disk, and the like unindurated weapons. At a later period armor became generally adapted for defense, and the tooth became the most efficient weapon of attack. Still later, armor was discarded, and flight or concealment became the main method of escape, and swift pursuit the principle of attack, while claws were added to teeth as assailing weapons. Finally, mentality came into play, intelligence became the most efficient

agent both in attack and defense, and a special development of the mind began. As a culmination of the whole, we have man, in whom mentality has replaced all other agents in the struggle for existence. But, side by side with man all the other types exist, the soft-bodied, the armored, the swift-moving, and those in which cunning precedes the higher mentality. In the existing conditions of life upon the earth we have an epitome of the whole long course of evolution."

**Acclimatization of Deer.** — Viscount Powerscourt has communicated to the Zoölogical Society of London the results of his experiments in acclimatization, conducted since 1858 and 1859, on his estate in Ireland, of foreign deer. He had at one time alive in a park of one hundred acres, about two thirds of which was open pasture and one third wood, red deer, Sambur deer, Nylghaies, axis deer, llamas, elands, wapiti deer, and moufflons, or wild sheep. The red deer increased and the wapiti bred, but the Nylghaies died while still apparently in good health. Accidents interfered with the success of the experiments with the wapitis, but the results, taken in connection with experiments made elsewhere, indicated that the acclimatization of these deer will be entirely practicable. The Samburs declined, and died in the course of three or four years, because, apparently, they insisted on staying in the shade. The elands, axis, and llamas died, or proved so delicate that they had to be taken away. The most favorable results were obtained with Japanese deer (*Cervus sika*), which throve excellently and multiplied without requiring other than the ordinary winter feeding. They are pronounced, after twenty-four years of breeding and increase, "a most satisfactory little deer; the venison when dressed is about the size of a Welsh mutton, and well flavored."

**Longevity of Great Men.**—In a paper read at the American Association, on "The Longevity of Great Men," Mr. J. Jastrow observed that all that the usual method of attempting to answer the question whether great men are longer lived than others can prove is that it takes long to become great. It neglects to consider that a select class of men is dealt with, and that to become potentially included in this class one must have lived a certain number of years. A review of a list of greatest men appeared to show that, on the average, a man must be thirty-seven years old in order to be a candidate for a place in this list. Comparing the ages to which such men live with the average expectation of life of men at thirty-seven, the author inferred that men of thought live three years longer, while the lives of men of feeling are three years, and those of men of action five years shorter than those of ordinary men—a conclusion which is somewhat different from the commonly accepted view on the subject. The question of longevity becomes important when we consider that through it the leaders of thought are allowed to exercise their important function here a few years longer, so that more great men are enabled to be alive at the same time. By the rule of heredity also, the children of great men will begin life with a better chance of reaching maturity and an age when they may become important to the world.

**Evils of Undiscriminating Charity.**—It is asserted by a clergyman residing in one of the districts where the most good was attempted to be done by its distribution, that the Mansion House charitable fund of London has done a vast amount of mischief in those very districts. This clergyman, Mr. Barnett, Vicar of St. Jude's, treats the fund as a calamity which has befallen London, not less, perhaps even greater, than the distress for which it was supposed to be the remedy. The evil arises from the failure to exercise discrimination in the administration of a bounty which, properly applied to the proper persons, might be made of great benefit. The failure in this case to accomplish an object designed to be good leads the "Spectator" to indulge in some remarks on the mischievousness of undiscriminating good feeling in general. There is hardly a single good feeling, it says, however just and praiseworthy in its kind, which men can simply indulge without incurring the greatest danger of doing harm. There is, for instance, the lavish habit of bestowing praise and blame in unmeasured volume, under the dictation of

mere impulse. "We see men and movements praised up to the skies which are full of dubious elements, half evil and half good, and other men and other movements as passionately censured which, again, are full of the same double character, half good and half evil. . . . The result undoubtedly is, that we give sympathy in the gross where only discriminating sympathy would be beneficial, and blame in the gross where only discriminating blame would be beneficial. And, as a natural consequence, we hatch all sorts of unhealthy eagerness to do what either ought not to be done at all, or else ought not to be done except by very carefully selected people, and all sorts of equally unhealthy eagerness to run down modes of action which in the right hands may be wise and good, though in the wrong hands they are pernicious in the highest degree."

## NOTES.

Mr. A. H. Allen, in a paper on oils, read in the American Association, said that shark and fish oils are often unsaponifiable, and hence are not fatty ethers. He believed them to contain cholesterine, like cod-liver oil. The fixed oils can be separated into groups, but we know no process for separating a mixture of lard and cotton-seed oil.

Professor A. R. Leeds reported to the Chemical Section of the American Association that his most careful analyses had given as the composition of human milk: albuminoids, varying from ·5 to 4·25 per cent; lactose, from 4·1 to 7·8 per cent; and fat, from 1·7 to 7·6 per cent. The appearance and specific gravity of the milk, he said, never indicate its composition.

M. Fayal has come to the conclusion that the rise in temperature to which the spontaneous combustion of coal-dust is due, is produced by the absorption of atmospheric oxygen. He finds that lignite is ignited at 300° C., anthracite at 500°, and other varieties of coal, in powdered form, at intermediate temperatures.

Dr. Börsch reported last year to the Meteorological Society at Berlin that three observers, working respectively at Berlin, Breslau, and Königsberg, to determine the differences of longitude between the three cities, noticed at the same moment abnormal deviations in the air-bubbles of their levels, which could be attributed to nothing else than movements of the ground. They afterward learned that some of the central parts of the Asiatic continent had at that very time been shaken with violent earthquakes. The supposition that the deviations noticed were connected with these shocks was confirmed by the fact that they were more marked at the eastward stations.

For the many millions of dollars that have been expended upon astronomy during the past two or three centuries, results have been obtained, says Professor E. C. Pickering, of Harvard College Observatory, whose value it is impossible to estimate. Apart from the knowledge it has given us of other worlds and of the laws governing the universe, it has furnished us information regarding this world which has been of enormous practical importance. It has secured safe and certain communication between distant countries, accurate maps, and the precise determination of time. The pecuniary value of these results would many times repay the total expenditure made for astronomical purposes.

A new edition of Professor Ferrier's "Functions of the Brain" is announced. The book has been nearly rewritten, and will include the results of new investigations by the author, and of investigations made by others during the last ten years.

The Rev. George Brown, missionary in the New Britain Islands, read a paper in the British Association in which he said that the results of fourteen and a half years of labor in Samoa among Polynesians, and in New Britain among Papuans, in reducing the languages and studying the manners and customs of the people, had convinced him that the Polynesian race was descended from the great Papuan stock with an Asiatic admixture. Mr. Fellows remarked upon this that if they went back far enough, a common origin would be found for all people. It was, therefore, desirable that some time of common origin should be fixed.

Mr. R. Warrington reported to the British Association that the results of his later experiments at Rothampstead showed a far deeper diffusion of the nitrifying organism in the soil than had been concluded from the earlier experiments. The power of producing nitrification was now found to exist generally down to three feet from the surface. Below this point the occurrence of the organism became less frequent, though at five and six feet about half the trials resulted in nitrification; with soil from seven and eight feet no nitrification was obtained. The considerable difference between the earlier and later results was to be attributed to the employment of gypsum in the later solutions.

THE Marquis of Lorne, in his presidential address before the Royal Geographical Society, cited, in illustration of the rapidity with which Africa is being opened up, the journey of Mr. Thomson to the capitals of Sokoto and Gando, the two great negro kingdoms of the Central Soudan. In four months from the date of his leaving Liverpool, Mr. Thomson, proceeding by way of the Niger, reached the capital of Sokoto with a party of one hundred and twenty West Coast negroes. He then negotiated a treaty of great commercial and political importance, and three months later was again in England, the whole journey having only occupied seven months. Twenty years earlier, it would probably not have been made in less than double that time.

M. PRADANOVIC, of Pesth, has devised a way of driving stakes by means of dynamite. He puts a plate of iron about four inches thick on the top of the stake, and on this he places his charge of dynamite. With a single cartridge, containing fifty-five grains of dynamite, he obtains five times as much force as with the average pile-driver. One of his iron plates is good for about twenty-five explosions.

SIR WILLIAM DAWSON observed in the British Association that as the result of his studies of the footprints of a species of limulus, it appeared that a number of impressions—protichnites and climactichnites—and supposed fossil fucoids, may be really tracks of crustaceans, and probably of trilobites and limuloids.

THE British Association passed a resolution expressing its solicitude that the exposed mummies of the Egyptian kings be carefully preserved against decay; and requested the owner of Stonehenge to take measures to secure that remarkable antiquity against dilapidation.

THE British Association received two invitations to visit Australia, or send a deputation there—one to Sydney, to assist in the celebration of the centennial of the first settlement of New South Wales, and the other to Melbourne. The General Committee decided to depute a number of representative members to attend the meeting of the Australian Associations in that year. The meeting for 1888 was appointed to be held in Bath. Sir Henry Roscoe was appointed to be the president of the meeting for 1887, which is to be held in Manchester.

THE British Government has decided to authorize the growing and curing of tobacco in the United Kingdom. In Europe, generally, the cultivation of this plant has greatly decreased during recent years. The acreage in the Netherlands is at present not more than about half what it was ten or twelve years ago. The decrease has been considerable, but not to so great an extent, in Belgium. In Austro-Hungary 8,768 acres less were under cultivation in 1884 than two years before; in Germany, 12,000 acres less in 1883 than in 1881. In Italy, 8,202 acres, and in France, 32,800 acres, were grown last year. In America, on the other hand, the crop rose from 199,752,655 pounds in 1850, to 472,661,117 in 1880, for the growing of which 638,841 acres were required. The crop of 1883 was 451,545,641 pounds from 635,739 acres.

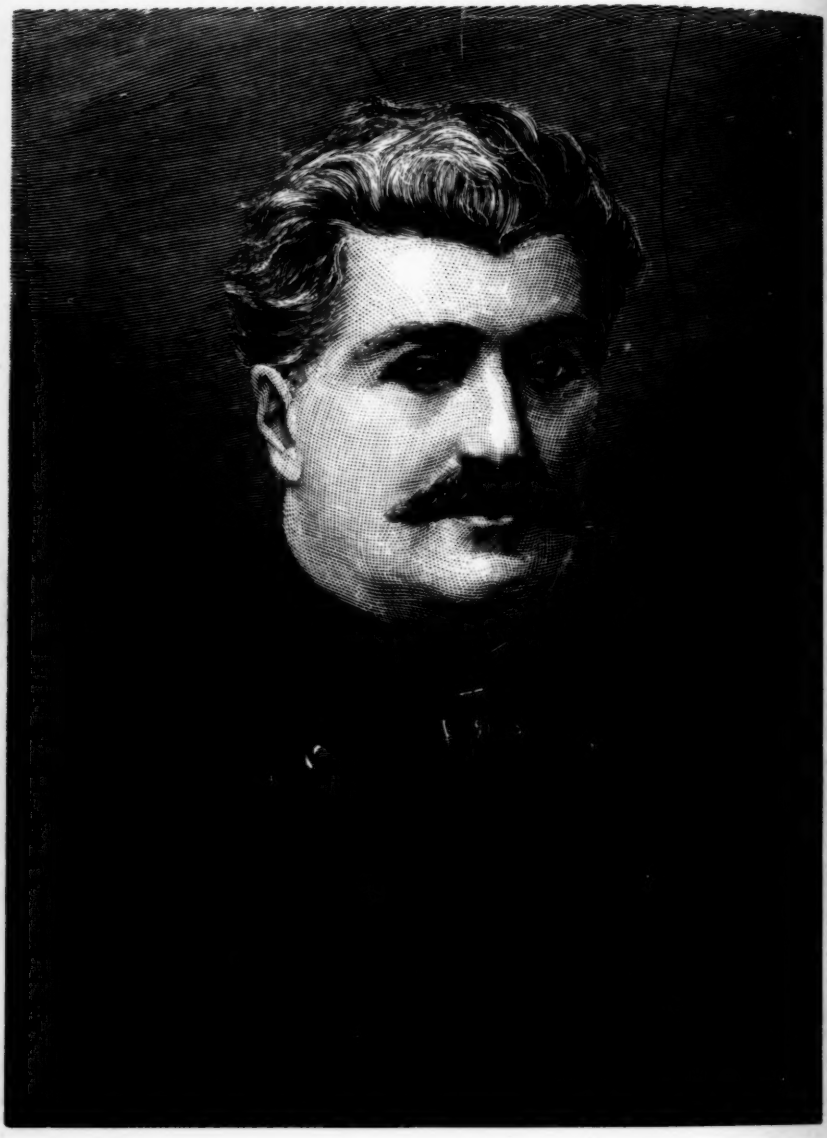
## OBITUARY NOTES.

MAURICE GIRARD, formerly Professor of Physics in the Collége Rollin, France, died in September. He was a naturalist of considerable merit, and an eminent entomologist; and was the author of a number of scientific and popular-scientific books, including a "Treatise on Entomology" and "The Metamorphoses of Insects" in the "Library of Wonders." He was connected with M. Tissandier's "La Nature" from its beginning.

ALEXANDER KRAPOTKIN, a man who has done some good work for science in Russia, died at Tomsk on the 6th of August, forty-five years of age. He translated Mr. Spencer's "Principles of Biology" and Clerk-Maxwell's "Theory of Heat" into Russian, and for several years contributed to Russian periodicals reviews of the progress of astronomy. In 1874 he was exiled to Minussinsk, in East Siberia, and there helped to organize a local museum, and carried on meteorological observations for several years. His most important work was a critical investigation of all our present knowledge of the stellar systems and the constitution of stellar groups, for which he made most thorough studies, but which he did not live to complete.

M. PAUL SOLEILLET, an adventurous French African explorer, has recently died, at the age of forty-four years. He went to Algeria when twenty-five years old, and spent a large part of his life in explorations of the interior, particularly of the Sahara. He started on a journey to Abyssinia in 1883.

DR. JAMES G. WAKLEY, editor of the London "Lancet," died at his home near Chertsey, August 30th. He was the youngest son of the late Thomas Wakley, founder of the "Lancet," and had himself been editor of that journal since 1862.



NICHOLAS PREJEVALSKY.